Vertebrate Microsite Assemblages (Exclusive of Mammals) from the Foremost and Oldman Formations of the Judith River Group (Campanian) of Southeastern Alberta: An Illustrated Guide

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by

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Cover photo: view from above Hanna's Ankylosaur Site (LSD 10, Sec 36, Tp 1, Rg 6, W4) located at lower centre of photograph.

Vertebrate Microsite Assemblages (Exclusive of Mammals) from the Foremost and Oldman Formations of the Judith River Group (Campanian) of Southeastern Alberta: An Illustrated Guide

ABSTRACT: Vertebrate microsite assemblages from the lower Judith River Group (the Foremost and Oldman formations) in the Milk River area of southeastern Alberta are systematically examined and documented for the first time. Nineteen vertebrate microfossil localities are analyzed, and 58 non-mammalian taxa are identified. A description of diagnostic features is provided, with an emphasis on identifying and distinguishing specimens from similar microsites. The lower Judith River vertebrate assemblages described herein show general similarities in taxonomic composition to those of the upper Judith River Group in Dinosaur Provincial Park, although palaeogeographical and evolutionary influences are also indicated.

Vertebrate microfossil localities (commonly known as microsites) occur in situations where small bones and teeth of vertebrates have become concentrated. Such localities generally yield taxonomically diverse aggregations of remains that include most of the vertebrate taxa known as macrofossils from the beds in which they occur (Dodson 1983; Brinkman 1990), as well as the remains of other taxa known only from the microfossil sites. Large sample sizes of vertebrate specimens can be obtained by way of surface collection or through the use of screenwashing techniques.

Studies of vertebrate microfossil localities from the Upper Cretaceous have shown that such accumulations generally contain very important and significant information for understanding the vertebrate fauna of ancient ecosystems (e.g., Estes 1964; Sahni 1972; Carpenter 1979; Brinkman 1987, 1990). For instance, abundant vertebrate microfossils from the upper Cretaceous Judith River Group of southern Alberta have been extensively studied and have provided much of the basis of our current understanding of the micro- and mesovertebrate assemblages of this area (e.g., Dodson 1983, 1987; Brinkman 1990). Such studies have largely been restricted to the upper Judith River Group (the Dinosaur Park Formation) and to the area of Dinosaur Provincial Park (DPP). Although vertebrate microfossils have also been found to be abundant in the lower Judith River Group (the Foremost and Oldman formations) in the Milk River Area of southeastern Alberta, such assemblages have not heretofore been systematically collected and documented, limiting the ability to make comparisons with the assemblages retrieved from DPP. Additionally, comparatively less abundant articulated vertebrate material has been recovered from the lower than in the upper Judith River Group in southern Alberta. Vertebrate microfossils thus become a very significant source for documenting vertebrate fossils from the lower Judith River Group. This contribution documents the vertebrate fauna of the Foremost and Oldman formations, on the basis of the results of an extensive survey of vertebrate microsites in the Milk River area of southeastern Alberta. The large samples upon which this contribution is based have been subjected to quantitative analysis (e.g., Shotwell 1955, 1958; Estes and Berberian 1970; Dodson 1983; Brinkman 1990), and these results will be presented elsewhere. As demonstrated by Brinkman (1990), such documentation of vertebrate microfossil assemblages, when combined with related sedimentological and taphonomic information, allow for palaeoecological hypotheses to be erected and tested.

Due to the incomplete nature of vertebrate microfossil material, and a scarcity of references documenting the material, taxonomic identification in microsite studies is often a difficult, tedious task. In an attempt to alleviate the situation, this contribution also provides a detailed description of all identified vertebrate microfossils (exclusive of mammals), along with accompanying photographic plates, with emphasis being placed upon identifying and distinguishing known non-mammalian vertebrate microfossils.

MATERIAL AND METHODS

Field research was carried out during the 1993 to 1996 field seasons and focused on recovering and investigating vertebrate fossils, specifically vertebrate microfossils, from the lower Judith River Group along the Milk River Valley and in its drainage area near the international border in southeastern Alberta (figure 1). Nineteen vertebrate microfossil sites from the Foremost and Oldman formations were located and subsequently sampled (figure 2). Basic information about these sites is provided in Appendix 1. Information about the sedimentology and taphonomy of these sites is given in Appendix 2. Vertebrate microfossils were then retrieved through both surface-collecting and screen-washing techniques. All material is catalogued in the Royal Tyrrell Museum of Palaeontology (RTMP), Drumheller, Alberta. A listing of all specimens recovered, organized by microsite, is presented in Appendix 3.

In the ensuing descriptions of the fossil vertebrate material recovered, the classificatory schemes of the following authors are adopted: Chondrichthyes (Cappetta 1987), Osteichthyes (Lauder and Liem 1983; Nelson 1984), Amphibia (Estes 1964; Duellman and Trueb 1994), Reptilia (Benton 1993), Squamata (Estes 1983; Estes *et al.* 1988; Gao and Fox 1996), Testudines (Gaffney and Meylan 1988), Crocodylia (Wu *et al.* 1996), Ornithischia (Horner 1990; Weishampel and Horner 1990), and Saurischia (Currie *et al.* 1990). Specimens have been assigned to the lowest possible taxonomic level, but between taxa this lowest assignment varies due to differences in the quality of preservation. Details of mammalian material recovered along with the aforementioned taxa will be presented elsewhere.

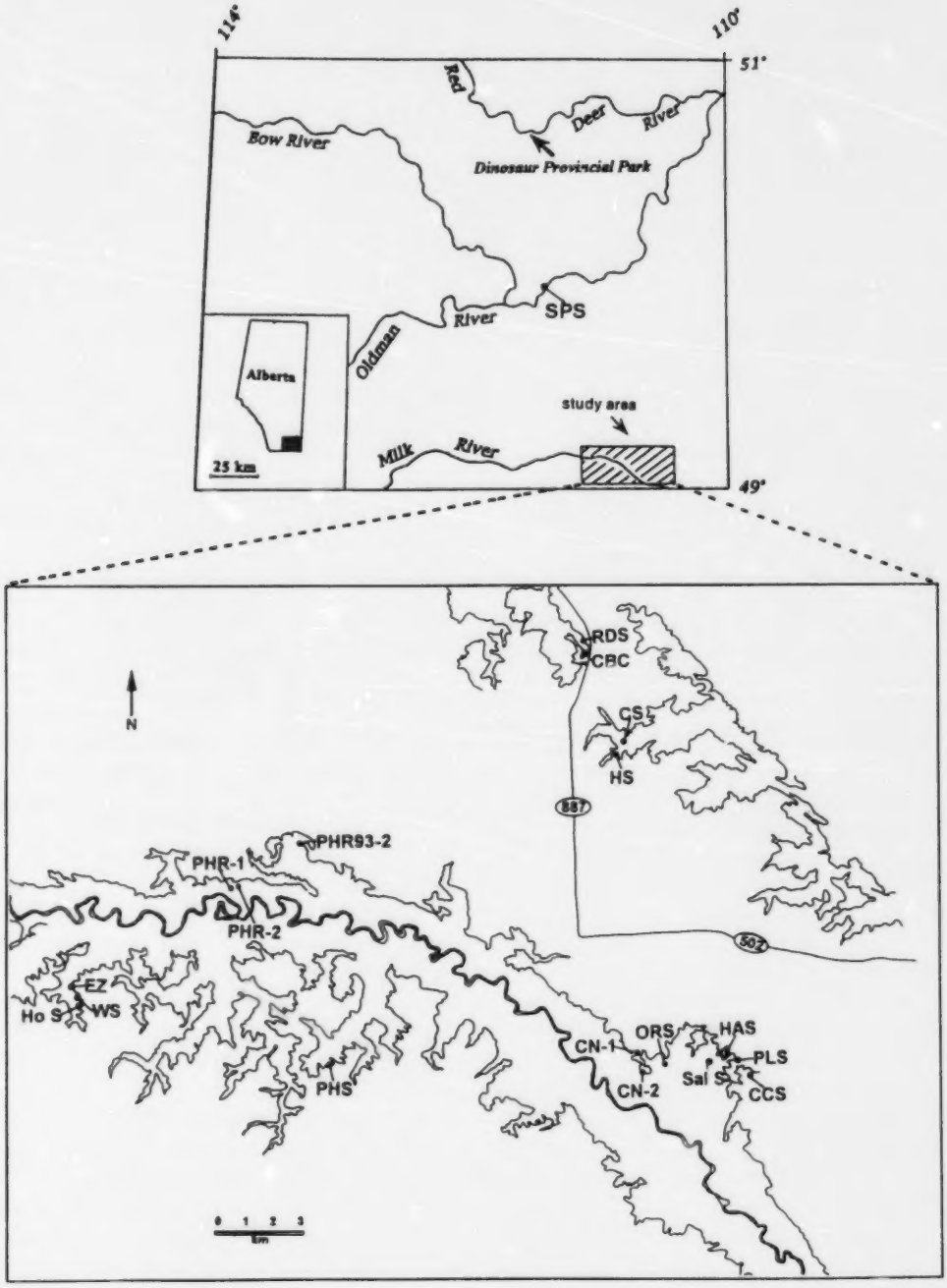


FIGURE 1. Locality map showing the geographic distribution of vertebrate microfossil sites from the Judith River Group in southeastern Alberta. The location of the site SPS is shown in the upper map, and the remainder of the 18 sites occur in the Milk River drainage area, as depicted in the lower map. Full names of the sites and a stratigraphic location of each are provided in Figure 2.

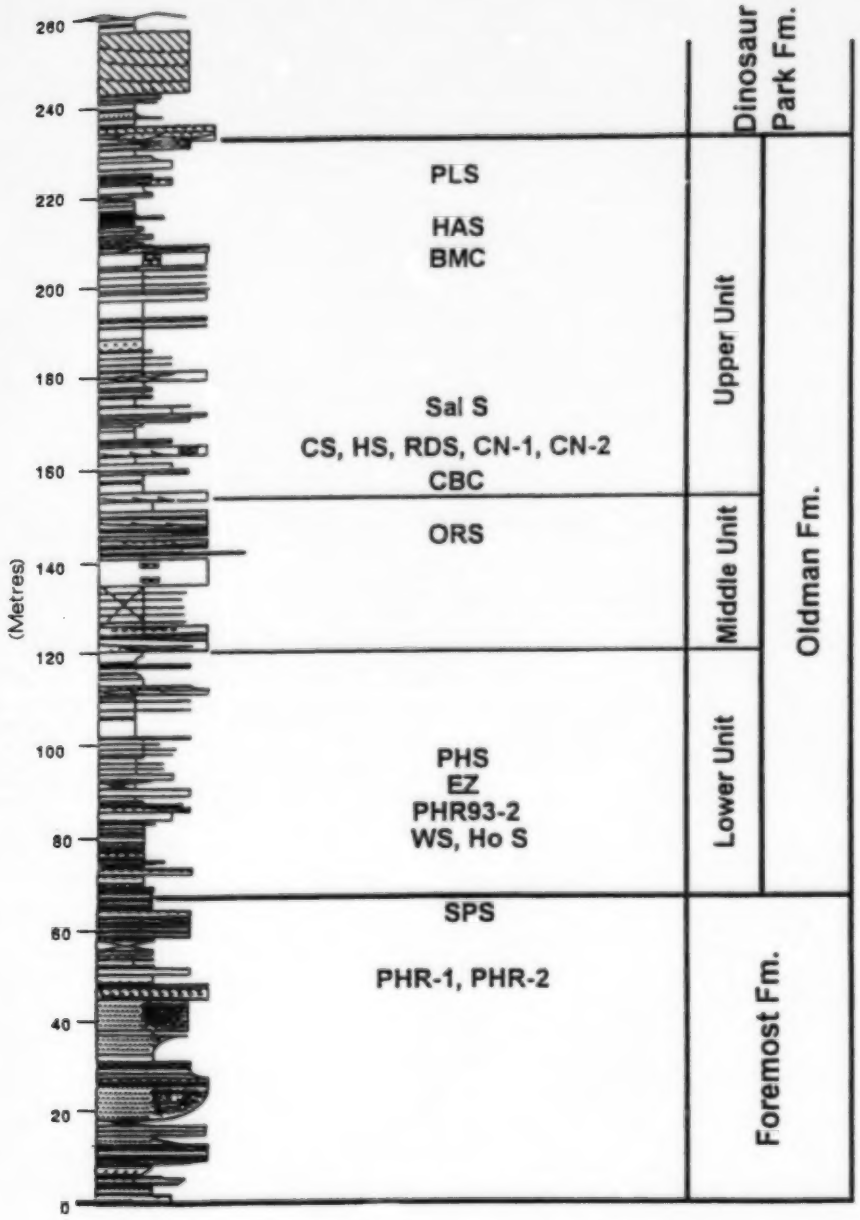


FIGURE 2. Stratigraphic positions of the vertebrate microsites sampled from the Judith River Group in the Milk River area of Alberta. The composite section of the study area is after Eberth and Hamblin (1993). Abbreviations for the sites, in ascending stratigraphic order, are: PHR-1, PHR-2 - Pinhorn Range #1, #2; SPS - Suffield Pumping Station Site; HoS - Hoodoo Site; WS - Wendy's Site; PHR 93-2 - Pinhorn Ranch #93-2; EZ - EZ Site; PHS - Pinhorn South Site; ORS - Old Road Site; CBC - Come-by-Chance Site; CS - Confluence Site; HS - Hanna's Site; RDS - Rainy Day Site; CN-1, CN-2 - Cecil Nesmo's #1, #2 Sites; SalS - Salamander Site; BMC - Big Muddy Channel Site; HAS - Hanna's Ankylosaur Site; PLS - Prairie Level Site. Locality and sedimentary data concerning these sites is available from the authors.

SYSTEMATIC PALAEONTOLOGY

Class CHONDRICHTHYES Huxley, 1880
Subclass ELASMOBRANCHII Bonaparte, 1838
Order EUSELACHII Hay, 1902
Family HYBODONTIDAE Owen, 1846
Genus HYBODUS Agassiz, 1837
Hybodus sp. indet.
Plate 1, figures 1-3

Material. *Hybodus* teeth (RTMP96.71.1 and 2) have been retrieved from only the Foremost Formation. They are represented mostly by a main (central) cusp, lacking a tooth root. Only one tooth (RTMP96.71.1) exhibits partial preservation of a root.

Description and Discussion. *Hybodus* teeth are readily identifiable by the presence of a low, rather mesio-distally expanded crown, with a distinctively robust, tall principal cusp (Case 1978; Cappetta 1987).

In addition to the aforementioned features, the teeth recovered in this study bear prominent mesial and lateral carinae on the principal cusp, and distinct plications extending up to half of the principal cusp height. The lateral cusplets are poorly developed or absent. These teeth are evidently referable to the genus *Hybodus*.

Hybodus teeth have also been described by Case (1978, 1987) from the Judith River Formation of Montana and the Mesaverde Formation of Wyoming, and by Beavan (1995) from the Foremost Formation of southern Alberta. Case (1978, 1987) erected two species of the genus, *H. montanensis* and *H. wyomingensis*, essentially on the basis of size differences. One of the features listed for *H. montanensis* by Case (1987:6), the absence of plications, conflicts with his description and illustration (Case 1978:180, text-fig. 2). Thus, this feature is here considered to be questionable for distinguishing the two species. More complete material is needed to clarify this. Currently, the teeth retrieved from this study can only be assigned as far as the genus *Hybodus*.

Order LAMNIFORMES Berg, 1958
Family ODONTASPIDIDAE Müller and Henle, 1839
Genus SYNODONTASPIS White, 1931
Synodontaspis hardingi (Cappetta and Case, 1975)
Plate 1, figures 4-7

Odontaspis hardingi Cappetta and Case 1975:20, pl. 7, figs. 1-16.
Odontaspis sanguinei Case 1978:190, pl. 4, fig. 12.
Carcharias hardingi Beavan 1995:68, pl. 2, figs. c-g.

Material. *Synodontaspis* teeth (RTMP96.71.3 and .4) have been recovered in this study only from the microsites of the Foremost Formation.

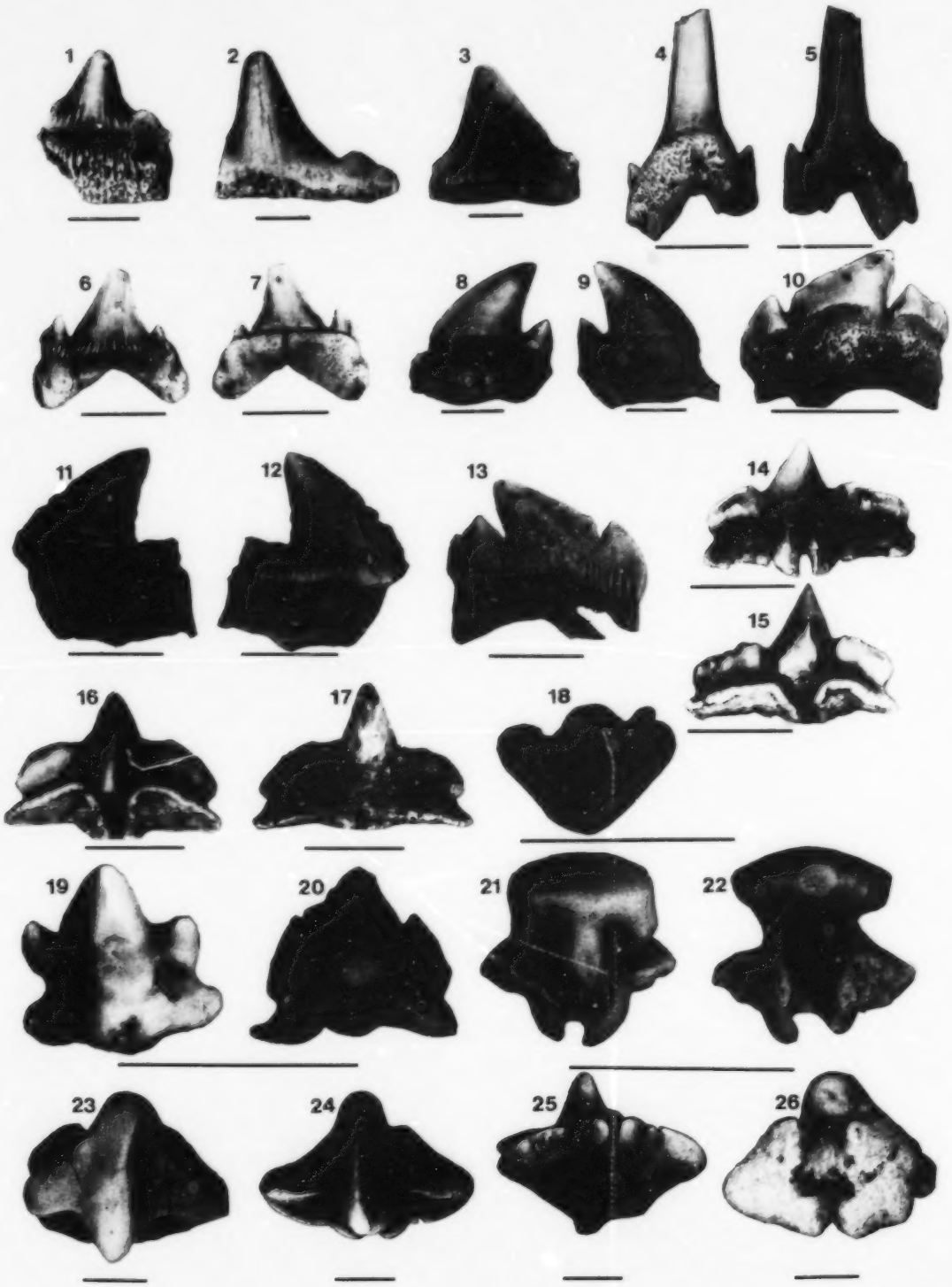
Description. The teeth are referable to *Synodontaspis* on the basis of the following features: they possess a tall, slender central cusp and a single pair of lateral cusplets; the central cusp is sigmoidal in profile view of each edge; the lingual face is smooth, and some bear weak, irregular longitudinal ridges; the labial face is flat, with some short longitudinal ridges at the foot of the crown; the cutting edges of the central cusp are prominent and thinly enameled; the roots are bi-lobed, with a deep nutrient groove on the lingual protuberance.

Discussion. This genus yields some of the most common fossil sharks found in the upper Cretaceous deposits of marine and estuarine facies in North America (Cappetta 1987). Such teeth have been identified under two generic names—*Carcharias* and *Synodontaspis* (e.g., Case 1978; Siverson 1992, 1995; Welton and Farish 1993; Beavan 1995)—resulting in some confusion. Cappetta (1987) suggested that *Carcharias* is a *nomen oblitum* [because *Carcharias* has been placed on the Official Index of Rejected Generic Names in Zoology (Name no. 1747, Opinion 723.5b, 1963)]. Thus the generic name *Synodontaspis* is applied here, and the teeth recovered in this study are referable to *S. hardingi*.

Family CRETOXYRHINIDAE Glückman, 1958
Genus ARCHAEOLAMNA Siverson, 1992
Archaeolamna kopingensis Siverson, 1992
Plate 1, figures 8-13

Plicatolamna arcuata Herman 1977:311, pl. 8, fig. 4; Case 1978:191, pl. 4, figs. 5-6; Case 1987:10, pl. 3, figs. 6-13.
Archaeolamna kopingensis Siverson 1992:534, pl. 2, figs. 16-20.

Material. Teeth of *Archaeolamna* include both lateral and posterior teeth (RTMP96.71.5).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Description. *Archaeolamna* teeth display a triangular, broadly based central cusp that is labiolingually strongly compressed and distally curved; a single pair of lateral cusplets is present, having a similar triangular form to that of the main cusp and being somewhat divergent from it. A lingual protuberance with nutrient pits is prominently developed.

Discussion. *Archaeolamna* teeth can be readily distinguished from those of *Synodontaspis* by the presence of a triangular and broadly based central cusp.

Order ORECTOLOBIFORMES Applegate, 1972
Family ORECTOLOBIDAE Jordan and Fowler, 1903
Genus SQUATIRHINA Casier, 1947
Squatirhina roessingi Case, 1987
Plate 1, figures 14-17

Squatirhina roessingi Case 1987:20, pl. 6, figs. 1a-6e.

Material. Specimens referred to *Squatirhina roessingi* are oral teeth. They are catalogued as RTMP96.71.6 and RTMP96.71.9.

Description. These oral teeth are minute, with the largest dimension of less than 3 mm. The central cusp is slender and sharply pointed. The well developed labial flange extends ventrally and close to the root area. The shoulders on either side of the central cusp are narrow, with a shallow notch between cusp and shoulder. The cutting ridges on the shoulders are often rough and discontinuous, indicative of their being vestigial cusplets. The root is dorsoventrally shallow, with a prominent groove on the ventral surface, which divides the root base linguolabially into two.

Discussion. The teeth recovered in this study are similar in the features described above to those of *S. roessingi* recovered from the Mesaverde Formation of Wyoming (Case 1987), and are thus assigned to that species. The teeth of *S. roessingi* resemble, in general appearance, those of *Squatina*, but are readily distinguishable by the presence of a prominent nutrient groove on the basal attachment surface. These teeth of *S. roessingi* represent the first record of this taxon reported from the upper Cretaceous of Alberta.

Family HEMISCYLLIIDAE Gill, 1862
Genus CHILOSCYLLIUM Müller and Henle, 1837
Chiloscyllium missouriense Case, 1979
Plate 1, figures 18-20

Chiloscyllium missouriense Case 1979:224, pl. 1, fig. 2; Case 1987:19, fig. 7.

Material. *Chiloscyllium* is represented by minute teeth (<1 mm). It is one of the most widely distributed (second to *Myledaphus*) elasmobranch taxa in this collection (Appendix 3) (fig. 2). Unlike *Myledaphus*, however, specimens are not common, and only one tooth has been recovered from each of the sites from which it has been retrieved, except for PHR-2 and SPS (Appendix 3).

Description. The crown is generally smooth (some have minor folds), with a long, broadly based cusp. A pair of accessory cusplets is either poorly developed or absent. The labial flange is prominent and round, and the root is low and cordiform in ventral view. The basal attachment surface is concave, with a large central nutrient foramen. The lingual root protuberance is penetrated by a foramen.

Discussion. Case (1979) described a species, *C. missouriense*, based on teeth, from the Judith River Formation of Montana. He later assigned more material from the Mesaverde Formation of Wyoming to the same species (Case 1987). The *Chiloscyllium* teeth identified in the present study are also referable to this species, although they differ in the variable presence of a pair of cusplets which are absent from the teeth from Wyoming and Montana. The current

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PLATE 1. Figs. 1-3. *Hybodus*. **1**, (RTMP96.71.1) lingual view of lateral tooth with partial root. **2**, (RTMP96.71.2) labial view; **3**, (RTMP96.71.1) labial view. **Figs. 4-7.** *Synodontaspis hardingi*. (RTMP96.71.4): anterior tooth in **4**, labial view; **5**, lingual view; **6**, lingual view; **7**, labial view. **Figs. 8-13.** *Archaeolamna kopingensis*. (RTMP96.71.5): **8** and **9**, lateral tooth in labial view; **10** and **13**, anterior tooth in labial and lingual view; **11** and **12**, lateral tooth in labial view. **Figs. 14-17.** *Squatirhina roessingi*. (RTMP96.71.9): oral teeth in **14**, lingual view; **15**, labial view; **16**, lingual view; **17**, labial view. **Figs. 18-20.** *Chiloscyllium missouriense*. **18**, (RTMP96.71.14) ventral view of root; **19**, (RTMP96.71.19) lingual view; **20**, (RTMP96.71.19) labial view. **Figs. 21-22.** *Rhinobatos casieri*. (RTMP96.71.13): **21**, lingual; **22**, labial view. **Figs. 23-26.** *Ischyrhiza mira*. (RTMP96.71.10): **23** and **24**, labial view; **25** and **26**, lingual view. **Scale bars for Figs. 1-13 = 3 mm; for Figs. 14-26 = 1 mm. Note that Figs. 19 and 20, and 21 and 22 share a single scale bar.**

findings represent the first occurrence of this genus in the upper Cretaceous of Alberta.

Herman (1977) noted that the specimens examined by Estes (1964, fig. 2a-b: U. C. no. 56272 and 53901) were mistakenly identified as symphyseal teeth of '*Lonchidion selachos*' and that they belong to the Orectolobiformes. These specimens appear to closely resemble the teeth of *C. missouriense* recovered in this study. Thus, it is suggested that they are referable to this taxon.

Order RAJIFORMES Berg, 1940
Family RHINOBATIDAE Müller and Henle, 1838
Genus RHINOBATOS Linck, 1790
Rhinobatos casieri Herman, 1977
Plate 1, figures 21-22

Rhinobatos casieri Herman 1977:126, figs. 5-9; Case 1987:22, pl. 5, figs. 3a-5c; Welton and Farish 1993:131, figs. 1-4.
Rhinobatos sp. Case *et al.* 1990:1092, figs. 12-13.

Material. *Rhinobatos* (RTMP96.71.13) teeth have been recovered only from the PHR-2 site. They are minute, with a maximum dimension less than 1.5 mm.
Description. The crown is smooth and is mesiodistally longer than it is labiolingually. On the lingual side, the crown sends a long median lingual uvula towards the base of the root, and this is flanked by similarly wide, but shorter, mesial and distal lingual marginal uvulae. The lateral protuberances are distinctly separated from the median protuberance by grooves, except for the region close to the dorsal crown. The root is massive and is separated by a deep groove into two lobes, each of which bears a lateral triangular process. A pair of nutrient foramina is present at the base of each triangular process.
Discussion. The *Rhinobatos* teeth reported here represent the first occurrence of this taxon from the Judith River Group of southern Alberta. They have, however, been described from the upper Cretaceous of Montana (Cappetta 1987). Although it has not been confirmed in extant species of the genus, Cappetta (1987) and Case *et al.* (1990) proposed sexual dimorphism of tooth structure in fossil forms. Only one type of tooth (the 'female' morph) has been recovered from site PHR-2. Whether this represents a preservational bias or whether it is due to other causes remains to be clarified by further study.

Family SCLERORHYNCHIDAE Cappetta, 1974
Genus ISCHYRHIZA Leidy, 1856
Ischyrhiza mira Leidy, 1856
Plate 1, figures 23-26

Ischyrhiza mira Leidy 1856:221; Storer and Johnson 1974:712, fig. 1; Case 1978:196, pl. 3, figs. 4-5; Case 1987:24, pl. 13, figs. 1a-e; Beavan 1995:75, pls. 5-6, figs. h-i.

Material. The retrieved specimens of *Ischyrhiza* include oral teeth (RTMP96.71.10), and one rostral tooth (RTMP96.71.11) from PHR-2.
Description. The oral teeth are referred to the genus on the basis of the following features: crown smooth, mesiodistally expanded with a single, short cusp and low, but rather broadly expanded shoulders; cusplets absent; labial flange well developed; cutting ridges prominent on cusp and the labial margin of shoulders (some teeth also have a cutting edge on the labial flange); root relatively high, with a flat basal attachment surface; a deep nutrient groove subdividing the root into two triangular lobes, a condition typical of the holaulacorhizous form (Cappetta 1987). The rostral tooth is typical of the genus in its form: the crown is laterally compressed, with sharp cutting edges both anteriorly and posteriorly; and it is also covered with smooth enameloid, and is slightly sinuous anteroposteriorly.
Discussion. Both the oral teeth and the rostral tooth described above exhibit the typical morphology associated with *Ischyrhiza mira* (Case 1978, 1987; Cappetta 1987), and can be referred to this species with certainty. The oral teeth are often more common and are readily identifiable by the presence of broad and low shoulders and the holaulacorhizous type of root (Cappetta 1987).

RHINOBATOIDEA *incertae sedis*
Genus MYLEDAPHUS Cope, 1876
Myledaphus bipartitus Cope, 1876
Plate 2, figures 1-3

Myledaphus bipartitus Cope 1876:260; Lambe 1902:28, pl. 19, figs. 1-2; Estes 1964:15, pl. 1, figs. 7-8; Sahni 1972:344; Johnson and Storer 1974:15, fig. 7; Case 1978:198, pl. 5, figs. 6-8; Carpenter 1979:41, fig. 7a-b; Breithaupt 1982:131.

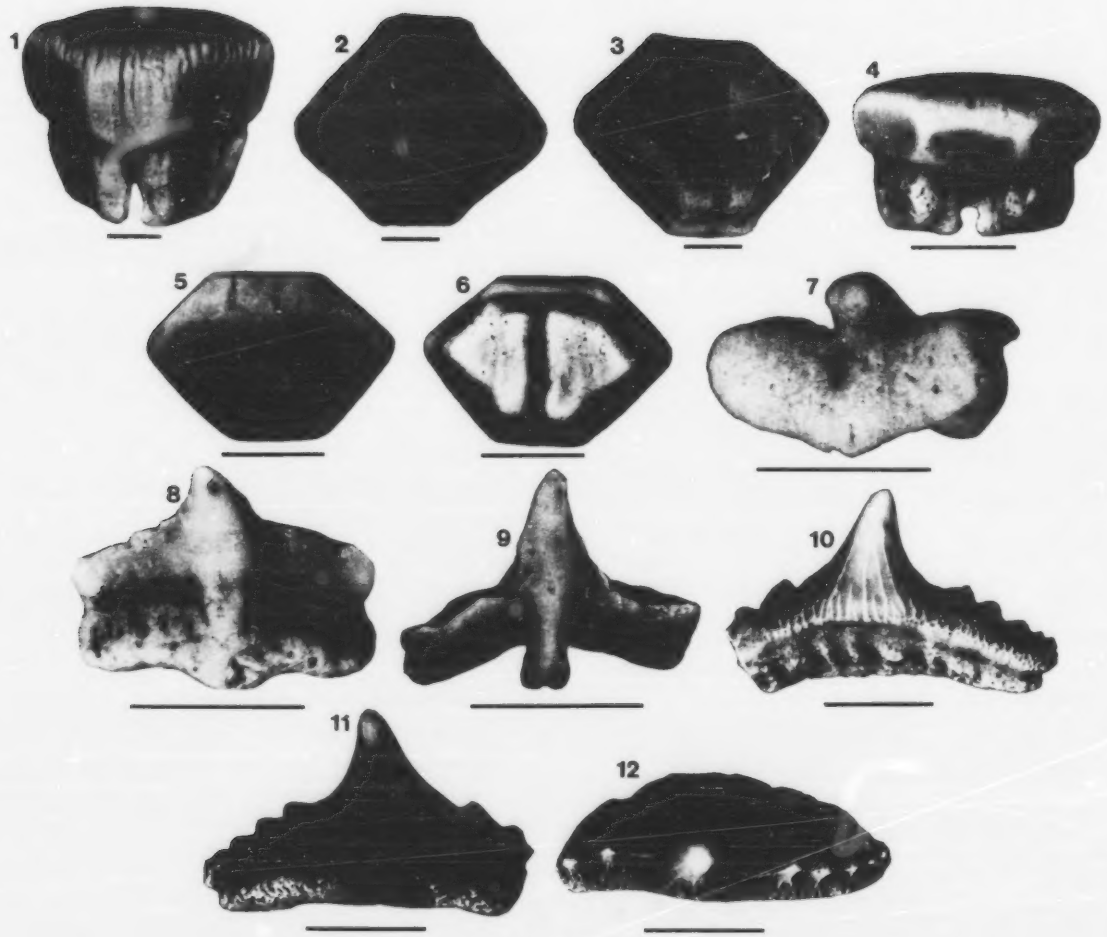


PLATE 2. Figs. 1-3. Teeth of *Myledaphus bipartitus*. (RTMP96.71.35): **1**, lingual; **2**, occlusal; **3**, basal view. **Figs. 4-6**. Teeth of *Myledaphus* sp. (RTMP96.71.20): **4**, lingual; **5**, occlusal; **6**, basal view. **Figs. 7-9**. Teeth of *Squatina hassei*. (RTMP96.71.8): **7**, basal; **8**, lingual; **9**, labial view. **Figs. 10-12**. Teeth of *Synechodus turneri*. (RTMP96.71.12): **10**, labial; **11**, lingual; **12**, occlusal view. **Scale bars = 2 mm.**

Material. The specimens referable to the species include isolated teeth (RTMP96.71.29-37), centra (RTMP96.71.38-39) and dermal denticles (RTMP96.71.40-42).

Description. Tooth size ranges from 1.3 mm high by 2.1 mm wide, to 3.7 mm high by 5.7 mm wide. The teeth are of the typical configuration for the genus, having a hexagonal crown and a bifid root that is invariably smaller in all dimensions than the crown. They are also distinctive in the following features: the flat occlusal surface is divided into two by a transverse ridge that is slightly arched labially, and bears numerous parallel enameloid folds that extend labiolingually; and the flattened sides of the crown are prominently marked with a series of vertical striations (wrinkles) that are often continuous with the enameloid folds on the occlusal surface.

Discussion. The teeth of *M. bipartitus* are readily identifiable by their distinctive form and by the presence of the prominent wrinkles on the lateral surface of the crown and the enameloid folds on the occlusal surface. This type of tooth is among the most widespread of elasmobranch fossils in the upper Cretaceous deposits of North America (e.g., Lambe 1902; Estes 1964; Sahni 1972). *Myledaphus* teeth recovered from the upper Judith River Group of DPP were also referable to this species (Brinkman 1990).

Myledaphus sp.
Plate 2, figures 4-6

Myledaphus bipartitus Russell 1935:120, pl. 2, fig. 1; Case 1987:28, fig. 11; Beavan 1995:74, pl. 5, figs. e-g.

Material. The specimens referred consist of isolated teeth, and they are catalogued as RTMP96.71.20–28.

Description. The teeth are very similar in overall configuration to those of *M. bipartitus*, but they are also distinctly different in that: i) they lack a series of perpendicular wrinkles on the flattened lateral surfaces of the crown; and ii) the occlusal surface of the teeth is generally smooth and plain, with a poorly developed transverse ridge (sometimes absent), and is devoid of parallel enameloid folds.

Discussion. Teeth referable to this taxon were found to be very abundant in the microsites of the Foremost Formation. They have also been reported and described in the Milk River Formation (Russell 1935). It is suggested that these *Myledaphus* teeth may represent a different species for the following reasons:

- They show distinct and consistent morphological differences from those of *M. bipartitus*, as described above;
- A great number of *Myledaphus* teeth covering a wide size range recovered from many different microsites suggests it is highly unlikely that the morphological differences simply represent individual variation;
- Stratigraphically, these distinctive teeth have so far consistently been retrieved only from the Milk River and Foremost formations in Alberta. Conversely, those of *M. bipartitus* are known from comparatively higher stratigraphic deposits.

More detailed examination is needed to formally describe these teeth as representing a new species. For now, they are referred to *Myledaphus* sp.

Order SQUATINIFORMES Buen, 1926
Family SQUATINIDAE Bonaparte, 1838
Genus SQUATINA Dumeril, 1906
Squatina hassei Leriche, 1929
Plate 2, figures 7-9

Squatina hassei Leriche 1929:68; Welton and Farish 1993:77, figs. 1-2.

Material. *Squatina* teeth (RTMP96.71.7-8) have been recovered from sites PHR-1and PHR-2. Surface collecting has indicated that they are also present in the lower Foremost Formation.

Description. The tooth crown is smooth, mesiodistally elongate, and bears a short, triangular cusp. The tooth shoulders are low, with sharp cutting ridges extending continuously across the shoulders and cusp. A labial flange is well developed and forms a distinct, rounded apron. The root is low and triangular in ventral view. The basal attachment surface varies from flat to slightly concave, and is perpendicular to the crown. The lingual root protuberance is prominent and covered with enameloid on its upper part. Multiple nutrient foramina are evident on the lingual root protuberance. A comparatively large central nutrient foramen is present at the centre of the ventral surface of the root. This foramen is connected to a smaller foramen at the tip of the lingual root protuberance through a canal, a condition representative of the hemiaulacorhizous root morph. According to Cappetta (1987), the hemiaulacorhizous condition refers to an elasmobranch root that has a central hollow basal face with an open central foramen that communicates by a medio-internal

foramen canal with the foramen on the lingual root protuberance.

Discussion. *Squatina* teeth are very close in their general appearance to those of *Squatirhina* and *Cretorectolobus*, an orectolobid shark known from the Judith River Formation of Montana (Case 1978). As noted by Welton and Farish (1993), *Squatina* teeth are, however, readily distinguishable from those of *Squatirhina* and *Cretorectolobus* by the absence of the nutrient groove on the ventral surface of the root.

GALEOMORPHII *incertae sedis* Cappetta, 1987
Family PALAEOSPINACIDAE Regan, 1906
Genus SYNECHODUS Woodward, 1888
Synechodus turneri Case, 1987
Plate 2, figures 10-12

Synechodus turneri Case 1987:8, pl. 2, figs. 1-5.
Paraorthacodus turneri Beavan 1995:73, pl. IV, figs. e-f.
Synechodus sp. Case 1973:129, fig. 109; Beavan 1995:73, pl. IV, figs. g-i.

Material. This genus is represented by only a single complete tooth (RTMP96.71.12).

Description. This specimen is a very small anterior tooth (6 mm wide and 4 mm high). Its principal cusp is straight, and is flanked by five pairs of lateral cusplets. Enamel folds are prominent on both the labial and lingual faces, which cover mainly the lower half of the crown. The base of the crown on the labial face overhangs the root via a slight bulge. The lateral cusplets are short, and are not distinctly separate from one another or from the cusp. The cutting ridges on the cusplets are united and join those of the central cusp to form a continuous, sigmoidal sharp edge in occlusal view. The lingual root protuberance is well developed and exhibits many nutrient foramina. The root is thick, and its baseline is arched in labial view while straight in lingual view. Some deep grooves are prominent on the labial side of the root, each displaying a single foramen at its base.

Discussion. Specimens attributed to this genus are relatively rare, and have not yet been discovered in the upper Judith River Group of DPP. *Synechodus* teeth are easily confused with those of *Paraorthacodus*, another genus of the same family, due to their similar morphology. According to Cappetta (1987), *Synechodus* is distinguishable mainly by the presence of its short, blunt lateral cusplets that are not distinctly separated from each other, in contrast to the teeth of *Paraorthacodus* that bear high, sharp lateral cusplets that are well separated from each other, and from the main cusp, by notches reaching the level of the root. In addition, *Synechodus* teeth are generally much smaller (<10 mm high) than those of *Paraorthacodus* (up to 20 mm high). Compared to the teeth of several species of the genus, the tooth described herein (RTMP96.71.12) is closely similar to those of *S. turneri* in general size, in that the lateral cusplets that are not independent of the central cusp and of each other, and in the enamel folds that cover mainly the lower half of the crown (Case 1987). Thus, it is referred to *S. turneri*.

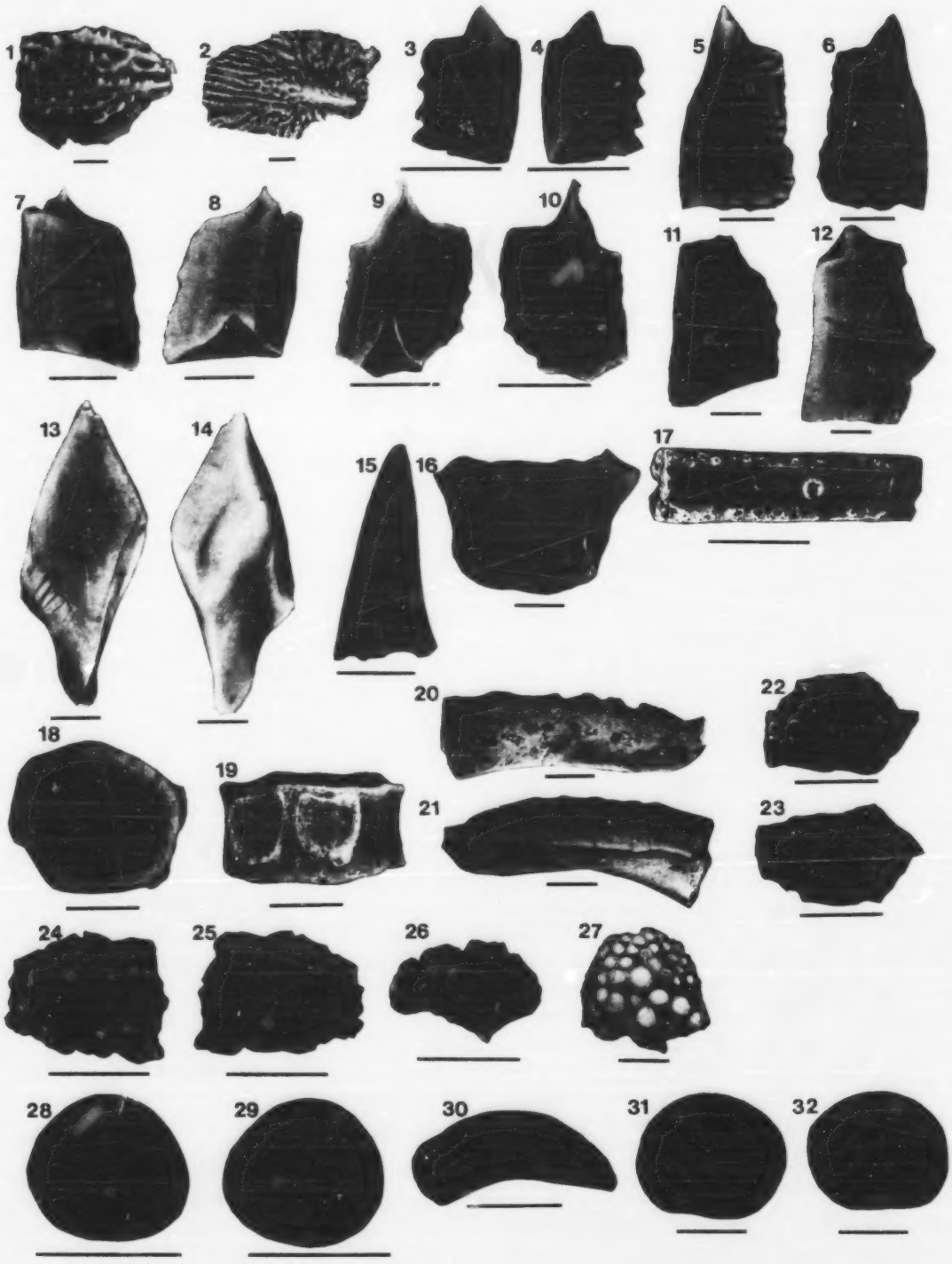
Class OSTEICHTHYES Huxley, 1880
Order ACIPENSERIFORMES Berg, 1940
Family ACIPENSERIDAE Bonaparte, 1831
Genus and species indet.
Plate 3, figures 1-2

Material. Sturgeon specimens recovered in this study are predominantly represented by fragments of dermal skull elements, and are catalogued as RTMP96.77.20-25.

Description. These specimens are referable to the family Acipenseridae on the basis of the distinctive sculpture patterns on the surface, which are typical of those of extant species of sturgeons. The distinctive sculpturings are the numerous flattened or crested ridges on the dorsal surface of the dermal cranial elements, which commonly radiate from the centre of an element. The identification of these elements is often difficult due to their fragmentary nature.

Discussion. Two genera of acipenserids, *Acipenser* and *Protoscaphirhynchus*, have been described from the upper Cretaceous of North America (Wilimovsky 1956; Estes 1964). Differences in sculpture patterns of cranial elements are unknown between the two genera. The specimens retrieved in this study are referable only to the family Acipenseridae due to their fragmentary nature, although most specimens of sturgeons recovered from the upper Cretaceous of North America have been referred to *Acipenser* (e.g., Estes 1964; Estes *et al.* 1969; Brinkman 1990).

Order indet.
Holostean A
Plate 3, figures 7-10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Material. Holostean A, described by Brinkman (1990:43, figs. 3A-C), is represented predominantly by bony scales. The scales retrieved in this study are referable to holostean A, and catalogued as RTMP96.77.45-62.

Description. Scales representing holostean A are small, ganoid, and greatly reduced in thickness when compared to those of *Atractosteus*. The peg-and-socket structures for articulation with anterior and posterior scales are well developed, with a ridge extending between the peg-and-socket on the internal surface. The lateral surface of each scale is covered with shiny ganoine, but lacks ornamentation. Holostean A scales retrieved in this study are very similar in morphology to those from the Dinosaur Park Formation of DPP (Brinkman 1990).

Holostean B
Plate 3, figures 3-6

Material. Holostean B was named by Brinkman (1990:43, fig. 3D) for the second type of holostean scale recovered from the Dinosaur Park Formation of DPP. Such scales have also been retrieved from the microsites examined in this study. Specimens are catalogued as RTMP96.77.63-67.

Description and Discussion. Holostean B scales are similar to those of holostean A in overall shape and in the reduction of scale thickness, as well as in the presence of a well developed peg-and-socket articulation. They differ, however, in that holostean B scales are generally larger and more elongate than holostean A scales, although a few holostean B scales are shorter (Plate 3, figs. 3-4), probably reflecting variation over the body surface. They are also different in that the lateral surface in a holostean B scale is ornamented with a series of continuous or broken shiny ganoine ridges extending laterally to the free edge of the scale. The stratigraphic distribution of holostean A and B scales is significantly different in that either both co-occur in microsites but have very different abundances between microsites, or only one type occurs exclusively at a given microsite. Similar patterns of stratigraphic occurrence were also noted by Brinkman (1990). Thus, it is highly unlikely that they simply represent sexual dimorphism or positional differences within the body of a fish.

Order ASPIDORHYNCHIFORMES Bleeker, 1859
Family ASPIDORHYNCHIDAE Bleeker, 1859
Genus BELONOSTOMUS Agassiz, 1834
Belonostomus longirostris (Lambe, 1902)
Plate 3, figures 11-12, 17

Diphyodus longirostris Lambe 1902:30.
Belonostomus longirostris Estes 1964:22, figs. 12-14.

Material. *Belonostomus* material recovered in this study is represented by scales and jaw fragments, and consists of specimens RTMP 96.77.68-71.

Description. The jaw fragments mostly represent the predentary portion of the lower jaw. They are laterally compressed and ventrally rather rounded. On the lateral surface they bear many longitudinal, rounded ridges, which are coated with ganoine. Dorsally, the predentary has a concave surface bearing a single, central row of large teeth, and two rows of small, closely-spaced teeth along the lateral edges.

Scales of *Belonostomus* are elongate, rectangular, and covered with a layer of smooth, shiny ganoine on the exposed outer surface. This surface is divided longitudinally into two facets, one inferior and one superior, by a ventroposteriorly oriented

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PLATE 3. Figs. 1-2. Acipenseridae gen. indet. Cranial elements in external view: **1**, (RTMP96.77.21); **2**, (RTMP96.77.20). **Figs. 3-6**. Holostean B. Bony scales: **3**, (RTMP96.77.64) external; **4**, (RTMP96.77.64) internal; **5**, (RTMP96.77.63) external; **6**, (RTMP96.77.63) internal view. **Figs. 7-10**. Holostean A. Bony scales: **7**, (RTMP96.77.60) external; **8**, (RTMP96.77.60) internal; **9**, (RTMP96.77.49) internal; **10**, (RTMP96.77.49) external view. **Figs. 11-12, 17**. *Belonostomus longirostris*. Bony scales: **11**, (RTMP96.77.68) internal; **12**, (RTMP96.77.70) external view. Jaw element: **17**, (RTMP96.77.71) occlusal view. **Figs. 13-16**. *Atractosteus occidentalis*. Bony scale (RTMP96.77.1): **13**, external; **14**, internal view. Tooth (RTMP96.77.194): **15**, lateral view. Vertebra (RTMP96.77.195): **16**, ventral view. **Figs. 18-23.** Amiidae gen. indet. Vertebra (RTMP96.77.169): **18**, anterior; **19**, dorsal view. Lower jaw (RTMP96.77.153): **20**, lateral; **21**, medial view. Toothplate (RTMP96.77.147): **22**, ventral; **23**, dorsal view. **Figs. 24-26.** *Coriops amnicolus*. Toothplate (RTMP96.77.95): **24**, ventral; **25**, dorsal; **26**, lateral view. **Figs. 27-29.** *Paralbula casei*. Toothplate (RTMP96.77.72): **27**, occlusal view. Tooth (RTMP96.77.73): **28**, basal; **29**, occlusal view. **Figs. 30-32.** Phyllodontinae gen. indet. Tooth stacks: **30**, lateral (RTMP96.77.175); **31**, basal (RTMP96.77.176); **32**, occlusal view (RTMP96.77.176). **Scale bars = for Figs. 1-17 = 2 mm; for Figs. 18-32 = 3 mm.**

ridge. The interior face of the scale shows a corresponding subdivision of its surface. The peg-and-socket articulation with anterior and posterior scales is generally poorly developed.

Discussion. Jaw fragments of *Belonostomus* are readily identified by the characteristic arrangement of rows of teeth and by the ornamentation on the outer surface. Scales of this taxon are easily separable from those of *Atractosteus* by their general shape and the subdivided external surface. They differ from those of holostean A and B in that the peg-and-socket articulation is poorly developed, and they lack ornamentation on the surface.

Family LEPISOSTEIDAE Cuvier, 1825
Order LEPISOSTEIFORMES Hay, 1929
Genus ATRACTOSTEUS Rafinesque, 1820
Atractosteus occidentalis (Leidy, 1856)
Plate 3, figures 13-16

Lepisosteus occidentalis Leidy 1856:73; Estes 1964:43, fig. 21; Estes *et al.* 1969:11; Sahni 1972:345; Breithaupt 1982:132.
Clastes occidentalis Cope 1884:73.
Atractosteus occidentalis Wiley 1976:66.

Material. *Atractosteus* specimens recovered from the microsites examined in this study are represented predominantly by scales, although a few isolated teeth and centra of *Atractosteus* have also been retrieved. Referred specimens are catalogued as RTMP96.77.1-19.

Description. The scales of *Atractosteus* are rectangular, thick, and heavy, with well developed lateral extensions, and are typical of the ganoid type of scale as represented in modern garfishes. They represent the thickest scales of all osteichthyan fishes recovered from the microsites examined in this study. The thickness of the scales, however, varies among specimens retrieved, which may be indicative of a regional difference within the body of the fish. The teeth of *Atractosteus* are elongate and sharply pointed. They are capped by bulbous, translucent tips. As a result, a constricted neck is prominent between the tip and crown. The tooth crown is ornamented on the surface with rather dense, longitudinal striations. The centra of *Atractosteus* are rather heavily built and opisthocoelous, a condition readily distinguishable from that of other osteichthyan fishes. Wiley (1976) suggested that opisthocoelous vertebrae are apomorphic for the family Lepisosteidae.

Discussion. Wiley (1976) discussed the phylogeny of the family Lepisosteidae and assigned the material that was often referred to *Lepisosteus occidentalis* from the upper Cretaceous in North America to *Atractosteus occidentalis*. This taxonomic arrangement is followed here. The scales of *Atractosteus occidentalis* are abundant in the upper Cretaceous of North America (e.g., Estes 1964; Brinkman 1990). They represent one of the most abundant taxa retrieved from most of the microsites examined in this study. Isolated teeth of *Atractosteus* are relatively rare. They are easily confused with those of *Champsosaurus* due to their similar size and general form. They can be distinguished, however, by the presence of the bulbous, translucent tip and the constricted neck between the tip and crown (figs. 6-15) in *Atractosteus*, features that are absent in *Champsosaurus*.

Order AMIIFORMES Huxley, 1861
Family AMIIDAE Bonaparte, 1837
Genus and species indet.
Plate 3, figures 18-23

Material. The specimens of amiids recovered from the microsites examined in this study are represented by jaws, toothplates (RTMP96.77.143 -159) and centra (RTMP96.77.160-174).

Description. Lower jaws of amiids are relatively abundant and are represented by dentaries. They are rather robust and bear only a single row of teeth. The tooth-bearing coronoid bones located on the medial face of the dentary are often not preserved. The premaxilla is a relatively short, plate-like element, with one row of large teeth along the edge. It has a flat, broad dorsal articulatory surface for the receipt of the nasals. The maxilla is a comparatively slender element, with a characteristic long, rod-like process projecting anteriorly for articulation with the premaxilla. Only a single row of small teeth is present on the maxilla. The toothplates are represented mostly by pterygoids, which are characterized by a single row of large teeth on the edge and multiple rows of small teeth medially. Parasphenoid toothplates are rare, but are distinctive in that they bear numerous tiny teeth. All of the toothplates are constructed from condensed bony plates, contrasting with the highly cancellous toothplates of *Coriops*. Amiid vertebrae are distinctive in that the centra are greatly shortened anteroposteriorly, the dorsal portion of each centrum is anteroposteriorly thicker than the ventral, and the

centra are oval in end view, and laterally directed parapophyses are present on the precaudal centra. Also, a distinct pair of pits is present ventrally that mark the position of cartilaginous processes that surround the dorsal aorta.

Discussion. Amiid fossil material has been found to be abundant in the late Cretaceous of North America (Estes 1964; Estes and Berberian 1970; Estes *et al.* 1969; Brinkman 1990; Grande and Bemis 1998). The specimens described above can be referred to the family Amiidae with certainty, based on the features described above. Identification at a lower taxonomic level, however, is not possible due to the incomplete, isolated nature of the material. Although Boreske (1974) assigned specific designation to much of the fossil amiid material that he examined from North America, Grande and Bemis (1998) were unable to confirm specific identity for fragmentary material and instead referred most of it to Amiinae indet.

Subdivision TELEOSTEI Müller, 1846
Order ELOPIFORMES Sauvage, 1875
Family PHYLLODONTIDAE Sauvage, 1875
Subfamily PARALBULINAE Estes, 1969a
Genus PARALBULA Blake, 1940
Paralbula casei Estes, 1969a
Plate 3, figures 27-30

Paralbula casei Estes 1969a:323, figs. 3a-f, 6c-e; Estes 1969b:11; Case and Schwimmer 1988:299, figs. 6.21-22.
Paralbula sp. Sahni 1972:345, figs. 7R-S.

Material. *Paralbula* specimens retrieved in this study are represented predominantly by isolated teeth, along with a few fragmentary basibranchial and parasphenoid tooth plates. The referred specimens are RTMP96.77.72-87.

Description. Unworn *Paralbula* teeth are hemispherical and, on the dorsal surface, bear coarse, rugose structures radiating from the centre. A basal rim with striated edges is present at the base of the crown. On the ventral surface a basilar foramen is evident in the centre. It appears that the foramina of unworn, replacement teeth are large, and that those of functional (usually worn) teeth have a comparatively smaller basilar foramen. It is thus postulated that the basilar foramen of the replacement tooth shrinks to a small opening, as it begins to move up and become a functional tooth. This is accomplished by the development of a thin layer of dentine that surrounds the foramen. As a result of this, the pulp cavity is almost closed. Such a morphological transition may be directly related to the strengthening of functional teeth, with more dentine being built up.

The partial basibranchial toothplate (RTMP96.77.72, Plate 3, figs. 27-29) reveals that the occlusal surface is convex, with the larger teeth being aggregated towards the centre of the toothplate and the smaller ones towards the edges. This arrangement of teeth is not, however, seen in the parasphenoid toothplate (RTMP96.77.83), on which teeth of various sizes are randomly distributed on its surface. The parasphenoid toothplate displays a slightly concave occlusal surface. Both surfaces of the toothplate are curved to some degree. A very thin bony layer is present on the attachment surface of the tooth plate. Both the basibranchial and parasphenoid tooth plates reveal that replacement teeth are irregularly stacked, as was described by Estes (1969a), and that about four generations of teeth are present on the toothplates.

Discussion. The majority of the isolated teeth and toothplates retrieved can be definitely assigned to *Paralbula casei*. The recovery of relatively complete parasphenoid tooth plates indicates that these may have been curved, which contrasts with the interpretation of Estes (1969a) who stated that the toothplates of *P. casei* lack a sigmoid curvature.

Subfamily PHYLLODONTINAE Dartevelle and Casier, 1949
Genus and species indet.
Plate 3, figures 30-32

Material. Isolated teeth and tooth stacks, catalogued as RTMP96.77.175-193.

Description and Discussion. These teeth resemble typical *Paralbula* teeth in their general 'button' shape, but differ in their large size (usually about 2-3 times larger). These large teeth are also different in that the replacement teeth are tightly stacked immediately below the functional teeth, and each tooth is very thin and has a sculptured occlusal surface. The pulp cavity is absent. Most specimens recovered represent isolated tooth stacks. They are similar to those of *Phyllodus* (Estes 1969a, fig. 1G-I; Estes and Hiatt 1978), which are also found as isolated, stacked teeth. Estes (1969a) interpreted them as the enlarged central teeth of the basibranchial tooth plate. However, such teeth are not present in complete basibranchials of *Paralbula* (e.g., RTMP66.23.10).

Thus, it can be concluded that they represent a distinct taxon of albulid. Until more complete basibranchial plates are recovered, the isolated tooth stacks are referred to as Phyllodontinae genus indet.

Family ELOPIDAE Romer, 1966
Genus PARATARPON Bardack, 1970
Paratarpon apogerontus Bardack, 1970
Plate 4, figures 1-2

Paratarpon apogerontus Bardack 1970:3, pl. 1, fig. 1; Brinkman 1990:42.

Material. A nearly complete centrum obtained from a surface-collected sample.
Description and Discussion. This specimen is the largest fish centrum recovered in the present study. The centrum is relatively narrow. It possesses prominent edges on both anterior and posterior ends. Numerous fine lamellae running parallel to one another are located between the anterior and posterior faces.

Bardack (1970) first described *Paratarpon* on the basis of an articulated postcranial skeleton from the Oldman Formation (equivalent to the Judith River Group here) of Alberta. More material of *Paratarpon*, including isolated centra and partial skeletons, was subsequently recovered from the Judith River Group of DPP, and was assigned to the same species (Brinkman 1990). The centrum recovered in the present study is clearly referable to this taxon on the basis of its morphology. It is readily distinguishable from all other teleosts in the assemblage by its size.

Family ALBULIDAE Bleeker, 1859
Genus CORIOPS Estes, 1969b
Coriops amnicolus Estes, 1969b
Plate 3, figures 24-26

Coriops amnicolus Estes *et al.* 1969:12.

Material. Specimens referable to *Coriops* are represented by only fragmentary basibranchial and parasphenoid tooth plates, and comprise specimens RTMP96.77.88-105.
Description and Discussion. The teeth on the toothplate are generally short and blunt, and are fused to it. The toothplate proper is constructed of cancellous bone, with the attachment surface being highly perforated. Teeth with broken crowns indicate that the pulp cavities were open, by way of a few small foramina, to the cavities within the toothplates. The toothplates of *Coriops* are distinguishable from those of amiids because of their cancellous bony plates. Amiid toothplates are highly compact. Similar toothplates of both *Coriops* and amiids have been reported from the Judith River Group of DPP (Brinkman 1990).

Order SALMONIFORMES Bleeker, 1859
Suborder ESOCOIDEA Bleeker, 1859
Family ESOCIDAE Cuvier, 1817
Genus ESTESESOX Wilson *et al.*, 1992
Estesesox foxi Wilson *et al.*, 1992
Plate 4, figures 3-6

Material. Specimens of esocoids recovered from the microsites in this study are represented by palatines, premaxillae, and jaw fragments (RTMP96.77.26-44).
Description. Esocoid fishes are distinctive in having hinged, depressible teeth (Wilson *et al.* 1992). Tooth crowns on the esocoid tooth-bearing elements retrieved in this study were mostly lost during preservation. As a result, only C-shaped tooth bases remain. The esocoid palatine, similar to those described by Wilson *et al.* (1992:843, fig. 5), is generally straight, and bears multiple rows of hinged, depressible teeth, with a prominent longitudinal ridge on the dorsal side (Plate 4, fig. 4). The premaxillae are very thin elements, with only a single row of depressible teeth. The lower jaws are comparatively robust and bear several rows of depressible teeth anteriorly, and fewer rows posteriorly.
Discussion. Two esocoid genera—*Estesesox* and *Oldmanesox*—have been described by Wilson *et al.* (1992) on the basis of lower jaws from the upper Cretaceous of southern Alberta. Nevertheless, most of the lower jaws recovered in this study are referable with certainty to *Estesesox* on the basis of the feature that all dentary teeth are depressible, with multiple rows anteriorly and fewer posteriorly. The lower jaws of *Oldmanesox*, according to Wilson *et al.* (1992), differ in the presence of a single row of large, fixed (rather than depressible) teeth posteriorly. Due to the fragmentary nature of specimens recovered, none of the lower jaw fragments can be certainly referred to this genus. In addition, although Wilson *et al.* (1992) did not include premaxillary specimens, these can be identified by the presence of a single row of depressible teeth, similar to those of *Esox* (Plate 4, fig. 5).

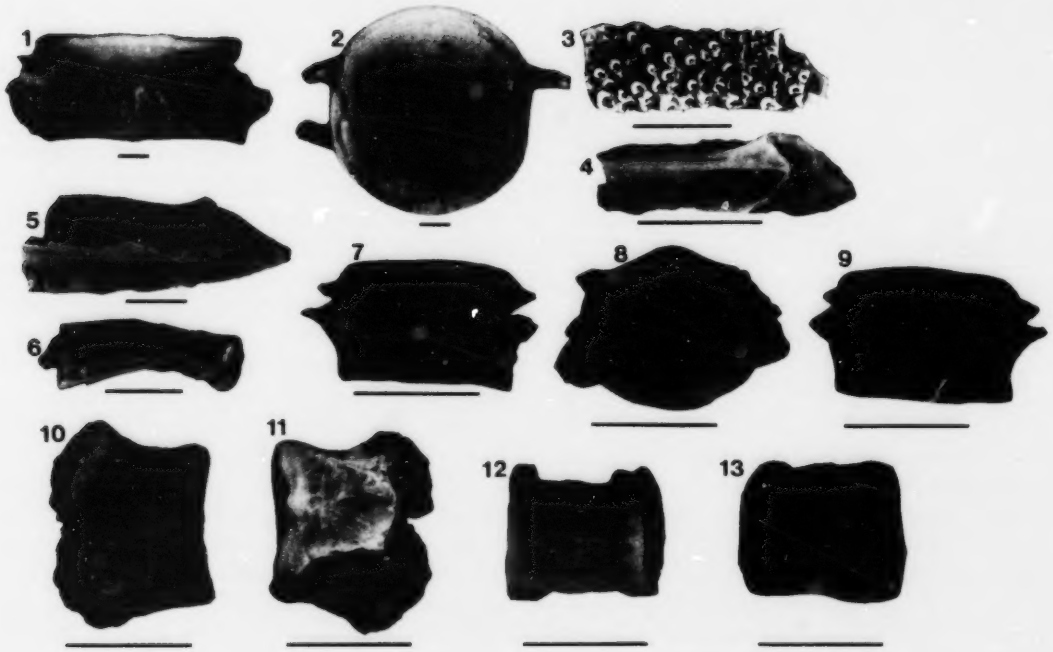


PLATE 4. Figs. 1-2. *Paratarpon apogerontus*. Vertebra (unaccessioned specimen): **1**, ventral; **2**, anterior view. **Figs. 3-6**. *Estesesox foxi*. Palatines: **3**, occlusal view (RTMP96.77.38); **4**, dorsal view (RTMP96.77.35). Right premaxilla (RTMP96.77.38): **5**, medial view. Left dentary (RTMP96.77.36): **6**, medial view. **Figs. 7-9**. Teleost D. Vertebra (RTMP96.77.119): **7**, dorsal; **8**, anterior; **9**, ventral view. **Figs. 10-13**. Teleost indet. Vertebrae: **10**, dorsal (RTMP96.77.135); **11**, ventral (RTMP96.77.135); **12**, ventral (RTMP96.77.138); **13**, dorsal view (RTMP96.77.138). **Scale bars = 3 mm.**

Order indet.
TELEOST D
Plate 4, figures 7-9

Material. Teleost D, described by Brinkman (1990:44, figs. E-F), is represented by a group of centra found in the Dinosaur Park Formation of DPP. This type of centrum has also been recovered from microsites examined in this study. They comprise specimens RTMP96.77.106-123.

Description. These centra are distinctive in having two large, circular pits for the attachment of the neural arch, with a small pit between these, and the presence of a long transverse process and a mid-ventral pit. Teleost D specimens retrieved in this study are abundant and can be readily distinguished from other teleost centra. They differ very little morphologically from those from the Dinosaur Park Formation of DPP.

TELEOST indet.
Plate 4, figures 10-13

In addition to Teleost D, further abundant teleost centra have been recovered from microsites examined in this study, (RTMP96.77.124 –142). Apparently, these represent teleost centra of many different types. A study of these is ongoing. For the present, therefore, they are simply referred to as teleost indet.

Class AMPHIBIA Linnaeus, 1758
Order CAUDATA Oppel, 1811
Family SCAPHERPETONTIDAE Auffenberg and Goin, 1959
Genus SCAPHERPETON Cope, 1876
Scapherpeton tectum Cope, 1876
Plate 5, figures 1-5, 10

Scapherpeton tectum Cope 1876:355; Estes 1964:62, fig. 33; Sahni 1972:348;
Carpenter 1979:41, figs. 9a-b; Breithaupt 1982:134.
Hemitrypus jordanianus Cope 1876:358.
Hedronchus sternbergi Cope 1876:359.

Material. Abundant specimens referable to *Scapherpeton* have been recovered from the microsites examined in this study. They consist of isolated vertebrae and dentaries, and are catalogued as RTMP96.78.62-80.

Description. The majority of the specimens of *Scapherpeton* are trunk vertebrae. They are diagnostic in being amphicoelous and having teardrop-shaped cotyles, and in lacking basapophyses and having a variably developed subcentral keel. According to Estes (1964), some isolated atlantes have been referred to this taxon. They are mostly represented by robustly built centra from which the neural arches have been detached. The atlas has a characteristically shaped anterior end that bears an intercotylar process (odontoid) and two lateral cotyles for articulation with the condyles of the skull. The intercotylar process is massive and has a prominent, ball-like condyle at its end and a constricted (neck-like) base that connects with the centrum proper. The dorsal surface of the process is grooved and continuous with the neural canal. The lateral cotyles flanking the intercotylar process are dorsoventrally depressed and oval-shaped, a characteristic of this taxon. The ventral side of the centrum is flat, with a variable number of foramina.

Some isolated lower jaw elements can be assigned to this taxon. Most of these specimens are dentaries, which are slender, elongate, and prominently curved medially. This contrasts with the condition in *Opisthotriton*, in which the dentaries are straight. The symphysis is extended posteriorly, forming an ovoid vertical plate. The subdental shelf is low and somewhat parallel with the ventral edge of the dentary. As a result, the tooth roots tend to be relatively long, extending over half the height of the dentary. A similar isolated dentary has been referred to the same taxon (Estes 1964). The crowns of the teeth are mostly broken off. The preserved roots are anteroposteriorly compressed and closely spaced.

Discussion. Several species of *Scapherpeton* were described by Cope (1876), based upon disarticulated material from the Judith River Formation of Montana. Only one species, *S. tectum*, was considered to be valid by Auffenberg and Goin (1959), based upon a review of the genus. Isolated specimens of this taxon have been discovered in a wide range of upper Cretaceous deposits, including the Milk River Formation of southern Alberta (Fox 1972, Table 1), the Judith River Group of DPP (Brinkman 1990, Table 1), the Judith River Formation of Montana (Cope 1876; Fiorillo 1989) and Saskatchewan (Estes 1981), the Hell Creek and Lance formations of Wyoming (Estes 1964), the Laramie Formation of Colorado, and the Foremost

and Oldman formations of southeastern Alberta (Estes 1981; this study).

Family BATRACHOSAURIDAE Auffenberg, 1958
Genus OPISTHOTRITON Auffenberg, 1961
Opisthotriton kayi Auffenberg, 1961
Plate 5, figures 6-9, 13

Opisthotriton kayi Auffenberg 1961:456, figs. 1-5; Estes 1964:81, figs. 38-41; Estes *et al.* 1969:13; Sahni 1972:350; Carpenter 1979:43, figs. 13, 14a-b; Breithaupt 1982:134.

Material. Specimens herein referred to this genus consist of dentaries and vertebrae, and are catalogued as RTMP96.78.81-99.

Description. The typical trunk vertebrae are identifiable by a combination of features as follows: the centrum is opisthocoelous, but the anterior condyle is somewhat rudimentary and is pitted in the centre; a pair of basapophyses is prominent on the posteroventral region of the centrum; and a subcentral keel is well developed. Atlantes like those referred to *Opisthotriton* by Estes (1964) have also been recovered in this study. This identification was confirmed by the discovery of an articulated specimen from the Palaeocene of Wyoming (Estes 1975). The atlantes resemble those of *Scapherpeton* in general form, but differ in that the intercotylar process is poorly developed, being expressed as a thin, shelf-like structure without a constricted base. The lateral cotyles of the atlas are generally round, in contrast to those of *Scapherpeton*, in which they are oval.

Isolated dentaries of *Opisthotriton* are distinguishable in that each is narrow anteriorly and widens greatly posteriorly, both dorsally and ventrally. The subdental shelf is high in the dorsal half of the dentary. As a result, the marginal tooth roots tend to be very low, in contrast with those of the dentaries referred to *Scapherpeton*. The subdental shelf, along with the baseline of the tooth row, rises toward the posterior end. A nearly complete left lower jaw (RTMP96.78.78) from the CBC site reveals that the tooth number appears to be lower than that of *Scapherpeton*, despite the fact that most tooth crowns are missing. It greatly resembles the lower jaws of *Opisthotriton* from the Lance Formation of Wyoming (see Estes 1964, fig. 39).

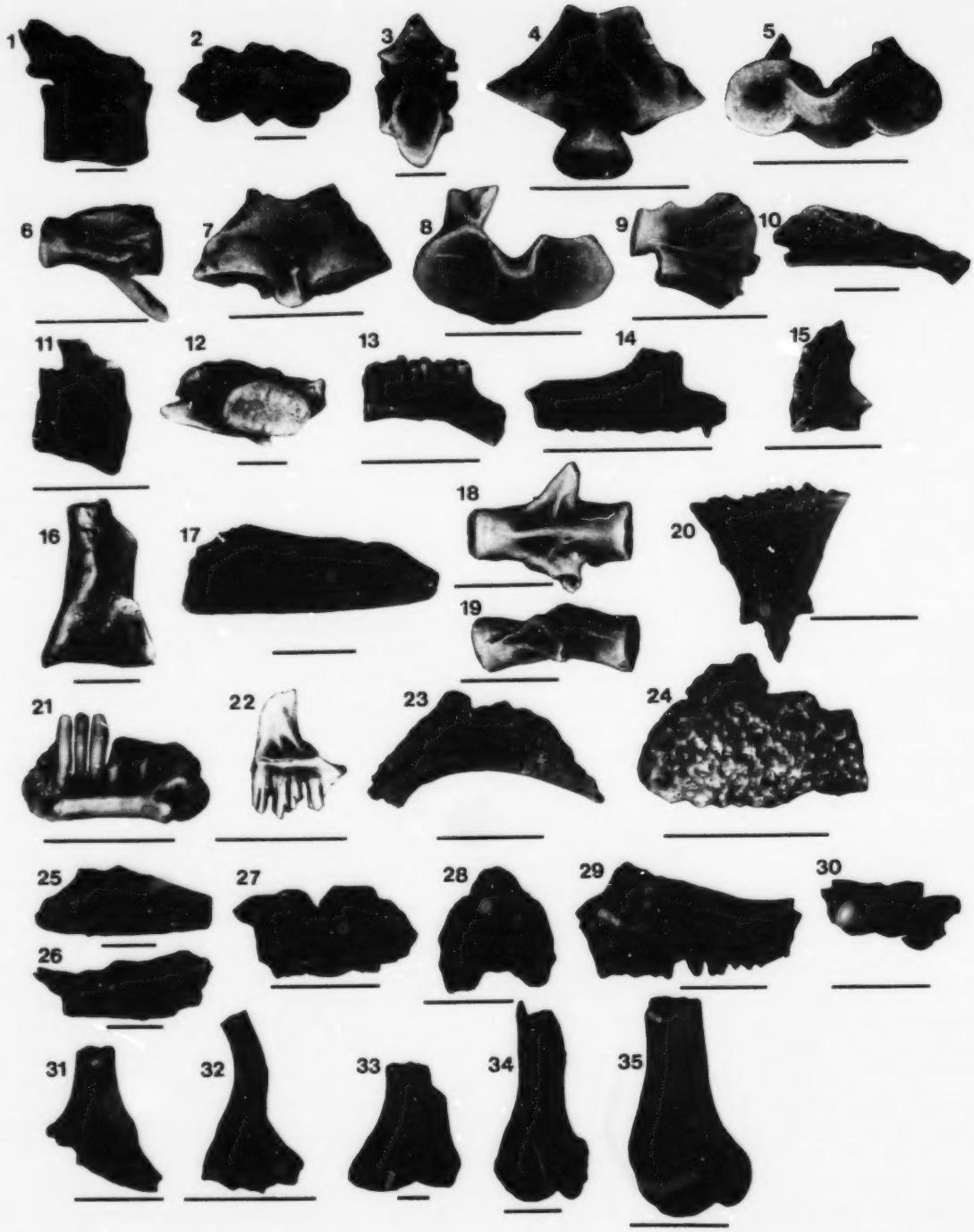
Discussion. *Opisthotriton* was described, based upon isolated vertebrae, from the Lance Formation of Wyoming (Auffenberg 1961). More material was subsequently recovered from the same deposits, and was described in detail by Estes (1964). Since then, *Opisthotriton* material has been reported from other Cretaceous deposits, such as the Milk River Formation of southern Alberta (Fox 1972, Table 1), the Judith River Group of DPP (Brinkman 1990), the Ravenscrag Formation of Saskatchewan and the Scollard Formation of Alberta (Naylor 1981), the Judith River Formation of Montana (Fiorillo 1989), the Hell Creek and Lance formations of Wyoming (Estes 1964), the Laramie Formation of Colorado, and the Foremost and Oldman formations of southeastern Alberta (this study). The *Opisthotriton* vertebrae recovered here show a strong resemblance to those from the Judith River Group of DPP and those from other deposits. Estes (1964) also described isolated elements other than vertebrae and dentaries, such as vomers, premaxillae and maxillae, and referred them to the same taxon. Such isolated elements were also recovered from the microsites examined in this study. However, the association of these elements with the isolated vertebrae of *O. kayi* cannot be established here due to the fragmentary nature of these specimens. They are described as Caudata indet. (see description below).

It is interesting and noteworthy that *Opisthotriton* material tends to co-occur with that of *Scapherpeton*, at least throughout the microsites examined in this study. The proportion of *Scapherpeton* to *Opisthotriton* specimens is quite consistent at about 2:1 among these microsites. Similar patterns have also been noted among the microsites of the Judith River Group of DPP, and may also be evident among the localities in the Lance Formation of Wyoming (Estes 1964).

Order CAUDATA Oppel, 1811
Genus and species indet.
Plate 5, figures 11-12, 14-17

Material. Additional specimens identified as Caudata indet. consist of isolated vomers, fused opisthotics-exoccipitals, quadrates, premaxillae, maxillae and postdentary bones. They are catalogued as RTMP96.78.100-175.

Description and Discussion. Vomers are represented by their anterior portions. They are somewhat similar in general form to those of *Habrosaurus* (Estes 1964: fig. 36a). Each consists of a vertical lateral edge and a flat medial plate. The process for articulation with the premaxilla is present at the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anterolateral corner of the lateral edge. A row of teeth is closely attached to the medial side of the lateral edge. Tooth numbers range from five to eight, in contrast with that of *Habrosaurus*, in which nine are present. The medial plate varies in its width among the specimens retrieved: some are relatively narrow strips and some are rather wide and short. These elements are noticably different from those of *Opisthotriton* in that they are elongate and triangular in shape (Estes 1964: figs. 40a-c). Estes (1964) referred a single vomer to *Scapherpeton*, but it was not illustrated, and features diagnostic for the genus were not identified.

Among the tooth-bearing caudate elements recovered in the present study, isolated premaxillae and maxillae are identifiable. The premaxillae are recognizable on the basis of their shortness, lingual curvature and their posterodorsally projecting nasal process. The premaxillary teeth are often missing. In many instances, only the wide nasal process is preserved. The posterior edge for articulation with the maxilla varies from short and oblique to high, with vertical surfaces. Isolated maxillae are recognizable by their straight, slender morphology and the presence of a dorsal process. The position of the dorsal process varies among specimens, arising from the anterior to the middle portion of the maxilla proper. Most of the maxillae are rather fragmentary, missing their teeth and the dorsal portion of the dorsal process. None of the maxillae can be certainly referred to either *Scapherpeton* (Estes 1964: fig. 33a) or *Opisthotriton* (Estes 1964: figs. 41d-e). Additional material and further study are needed to clarify their taxonomic assignment.

Abundant caudate fused opisthotic-exoccipital complexes were identified. These are readily recognizable based on the presence of a small ovoid and small medial articular facet. Each complex is robustly built and the opisthotic is fused laterally to the exoccipital. Some specimens display a large jugular foramen between the opisthotic and exoccipital. The exoccipital bears the prominent, posteriorly oriented condyle and the medial facet. This facet is smaller than the condyle and forms an articulation with the intercotylar process of the atlas. The condyle is generally ovoid, with a rough, flat surface for articulation with the cotyle of the atlas. The ovoid condyle matches well with the oval-shaped cotyle of the atlas of *Scapherpeton* (see description above) and thus these isolated elements may be assignable to *Scapherpeton*. No examples of such opisthotic-exoccipital complexes bearing condyles with round articular surfaces, which match the round cotyles of the atlas of *Opisthotriton*, have been certainly identified here. This may be due to the incompleteness of the material.

Isolated quadrates of caudates are all represented by their articular portions. Each quadrate is a pillar-like element, with a concave articular surface at its distal end. Two different types of quadrate, described here as Type A and B, are recognizable. Type A is distinctive in that the articular surface is large and deeply concave, and in that the shaft is elongate and is evidently smaller in cross-section than is the articular end. The lateral surface bears a large, shallow depression as the articular facet for the ventral process of the squamosal. The anterior surface is expanded medially and bears numerous, small nutrient foramina. Type B differs in that the articular

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PLATE 5. Figs. 1-5, 10. *Scapherpeton tectum*. Trunk vertebra (RTMP96.78.71): **1**, lateral; **2**, ventral; **3**, anterior view. Atlas (RTMP96.78.148): **4**, ventral; **5**, anterior view. Left lower jaw (RTMP96.78.146): **10**, medial view. **Figs. 6-9, 13.** *Opisthotriton kayi*. Trunk vertebra (RTMP96.78.95): **6**, ventral; **9**, lateral view. Atlas (RTMP96.78.149): **7**, ventral; **8**, anterior view. Right lower jaw (RTMP96.78.147): **13**, medial view. **Figs. 11-12, 14-17**. Caudata genus and species indet. Right vomer (RTMP96.78.150): **11**, ventral view. Opisthotic-exoccipital (RTMP96.78.169): **12**, posterior view. Right maxilla (RTMP96.78.168): **14**, lateral view. Left quadrate (RTMP96.78.188): **15**, anterior view. Left quadrate (RTMP96.78.206): **16**, posterior view. Postdentary bone (RTMP96.78.207): **17**, lateral view. **Figs. 18-20.** *Albanerpeton* sp. Trunk vertebra (RTMP96.78.144): **18**, ventral; **19**, lateral view. Frontal (RTMP96.78.136): **20**, dorsal view. Left lower jaw (RTMP96.78.107): **21**, medial view. Right premaxilla (RTMP96.78.121): **22**, medial view. **Figs. 23-31, 33-35.** Anura genus and species indet. Cranial element (RTMP96.78.17): **23**, external view. Right squamosal (RTMP96.78.11): **24**, external view. Right maxilla (RTMP96.78.34): **25**, lateral view. Maxillae in medial view: **26**, (RTMP96.78.36); **29**, (RTMP96.78.31). Trunk vertebrae in ventral view: **27**, (RTMP96.78.45); **28**, (RTMP96.78.46); **30**, (RTMP96.78.50). Left ilia in lateral view: **31**, (RTMP96.78.226); **33**, (RTMP96.78.227). Humeri: **34**, (RTMP96.78.56); **35**, (RTMP96.78.59). **Fig. 32.** Caudata gen. indet. Left ilium (RTMP96.78. 228): **32**, lateral view. **Scale bars for Figs. 1-17 = 3mm; for Figs. 18-35 = 2 mm.**

surface is saddle-like and expanded laterally, and in its stout and short shaft. The articular facet for the squamosal is present on the anterolateral edge of the shaft, far above the articular end, which contrasts with Type A, in which the articular surface closely approaches the articular end of the quadrate. Type A is much more abundant than Type B. Although Type A is somewhat similar to that of *Opisthotriton*, as described by Estes (1964), its referral to that genus cannot be confirmed until additional associated material is retrieved.

Isolated caudate postdentary complexes, typically consisting of the articular, pre-articular and angular, were recovered. These specimens are identifiable on the basis of the presence of a large, semicircular, and convex articular condyle at the posterior end. A foramen is present on the outer surface, below the condyle. The articular, pre-articular and angular are so highly fused that sutures are not evident. The anterior portion of the postdentary is slender and elongate, and dorsally forms a vertical, thin plate. Such isolated postdentaries have not yet been reported or described from other Cretaceous deposits of North America, although similar elements have been found in the Judith River Group of DPP (Brinkman unpublished).

Order ALLOCAUDATA Fox and Naylor, 1982
Family ALBANERPETONTIDAE Fox and Naylor, 1982
Genus ALBANERPETON Estes and Hoffstetter, 1976
Albanerpeton sp.
Plate 5, figures 18-22

Material. Specimens referable to *Albanerpeton* are represented by isolated premaxillae, maxillae, frontals, dentaries and trunk vertebrae. They are catalogued as RTMP96.78.100-145.

Description. The premaxillae, maxillae and dentaries are very similar to those of *Albanerpeton* that have been recovered from the Milk River Formation and described in detail by Fox and Naylor (1982). The dentary is distinctive in the presence of a lobate, interdigitating symphysis, which is one of the diagnostic features of *Albanerpeton*. All of these jaw elements bear non-pedicellate, pleurodont teeth. Isolated frontals have also been identified. Each is generally triangular and plate-like, with the anterior end narrowing almost to a point and the posterior end widening. A pair of small facets for articulation with the nasals is present. These extend anterolaterally close to the anterior end of the frontal. The dorsal surface of the frontal is sculpted, the patterns of which are similar to those described for anurans in which pitted circles are encompassed by continuous ridges. The sculpting on the frontals of *Albanerpeton* frontals is, however, comparatively finer and the ridges are lower. A few trunk vertebrae can be tentatively assigned to *Albanerpeton* (Plate 5, figs. 18-19). They are small and elongate, with low neural arches and poorly developed neural spines. Their centra are smooth ventrally and lack the subcentral keels and basapophyses that are typical of *Opisthotriton*. Both ends of the centra are deeply concave and round in shape, in contrast to those of *Scapherpeton* vertebrae that have teardrop-shaped cotyles.

Discussion. Material of *Albanerpeton* is readily distinguishable from that of other caudate-like amphibians recovered from these deposits by the features described above. This taxon has been found widely in the Cretaceous deposits of North America (e.g., Fox and Naylor 1982). Its recovery from the microsites examined in this study represents the first record of this taxon from the Foremost and Oldman formations of southern Alberta. A review of albanerpetontid material at lower taxonomic levels is ongoing (J.D. Gardner 1997, pers. comm.). For now, the material recovered in this study is temporally referred to the generic level only.

Order ANURA Giebel, 1845
Family indet.
Plate 5, figures 23-31, 33-35

Material. Specimens referable to the Anura are represented by cranial elements, presacral and sacral vertebrae, humeri, and ilia. They are catalogued as RTMP96.78.1-61.

Description. Cranial fragments are the most abundant specimens. They are distinguishable in that their outer surfaces bear characteristic sculpturing formed by dense and continuous ridges bounding numerous subequal circles. A few cranial fragments, nevertheless, display different and irregular sculpturing patterns. Among these cranial specimens, complete and partial jaws (including maxillae and dentaries), squamosals, and frontoparietals are identifiable. The tooth-bearing elements possess very small, pointed teeth with evident cement deposited at their bases. As a result, the roots of such teeth are affixed together and are hard to separate. This

condition can be readily distinguished from that of caudates, in which the roots are clearly separate.

The vertebrae are, in general morphology, typical of those of extant frogs. Most of them, lacking neural arches, are represented by centra. Among the presacrals, four types of centra are evident: procoelous, amphicoelous, opisthocoelous, and biconvex. The procoelous centra are most abundant, followed by the amphicoelous and opisthocoelous types. Only one centrum (RTMP96.78.46) was found to be biconvex, a very unusual condition among anurans. Until more specimens are recovered, it is here interpreted as an individual variation. Sacral vertebrae are distinctive, as they are for extant frogs, in that they bear posterior bicondylar articular facets. A relatively complete sacrum (RTMP96.78.60) indicates that the transverse processes (diapophyses) are rather wide anteroposteriorly, a feature considered to be primitive (Trueb 1973).

The ilium of anurans is identifiable in that its elongate shaft curves anteriorly and is essentially rod-like, with a compressed oval cross-section, and in that the acetabular fossa is large and occupies over a half of the ventral portion of the ilium proper. A large depressed area is prominent on the medial surface, opposite the lateral acetabular fossa. Such specimens can be confused with the ilia of salamanders retrieved from the same microsites examined in this study, due to their similar appearance. They are distinguishable, however, in that salamander ilia are relatively slender, with a sigmoidal shaft and a rather round cross-section, and a small acetabular fossa that is about one-third the length of the ilium proper (Plate 5, fig. 32).

Humeri of anurans are here represented only by their distal ends. Each is distinctive in the presence of a large, ball-like articular condyle, which is typical of those of extant anurans.

Discussion. The anuran specimens described above are readily distinguishable from other microvertebrate specimens on the basis of their characteristic form, such as the sculptured cranial elements, and the peculiar form of the vertebrae and ilia. All anuran material recovered to date from the Cretaceous deposits of North America is represented by disarticulated skeletal elements (Estes 1964, Estes *et al.* 1969; Brinkman 1990). The taxonomic assignment of these Cretaceous specimens is tentative (e.g., Estes 1964), due to the lack of articulated specimens and poor documentation. Estes *et al.* (1969) and Estes and Berberian (1970) have been able to assign some anuran remains from similarly aged strata to the Discoglossidae and tentatively to the Pelobatidae, but additional specimens and further study are required to determine the identity of the Cretaceous anurans recovered in this study. Currently, they are identifiable only as Anura, family indet.

Class REPTILIA Laurenti, 1768
Subclass ANAPSIDA Williston, 1917
Order TESTUDINES Batsch, 1788
Suborder CRYPTODIRA Cope, 1868
Suborder EUCRYPTODIRA Gaffney, 1975

Late Cretaceous turtles from North America have been described on the basis of both disarticulated fragments and articulated skeletons. For instance, baenid turtles were documented by Gaffney (1972), adocids by Meylan and Gaffney (1989), and trionychids by Gardner *et al.* (1995). The turtle material, especially from vertebrate microsites, is commonly represented by shell fragments (e.g., Estes 1964; Sahni 1972; Brinkman 1990). All of the turtle specimens retrieved from the microsites in this study are carapace and plastron fragments.

Family BAENIDAE Cope, 1882
Genus and species indet.
Plate 6, figure 1

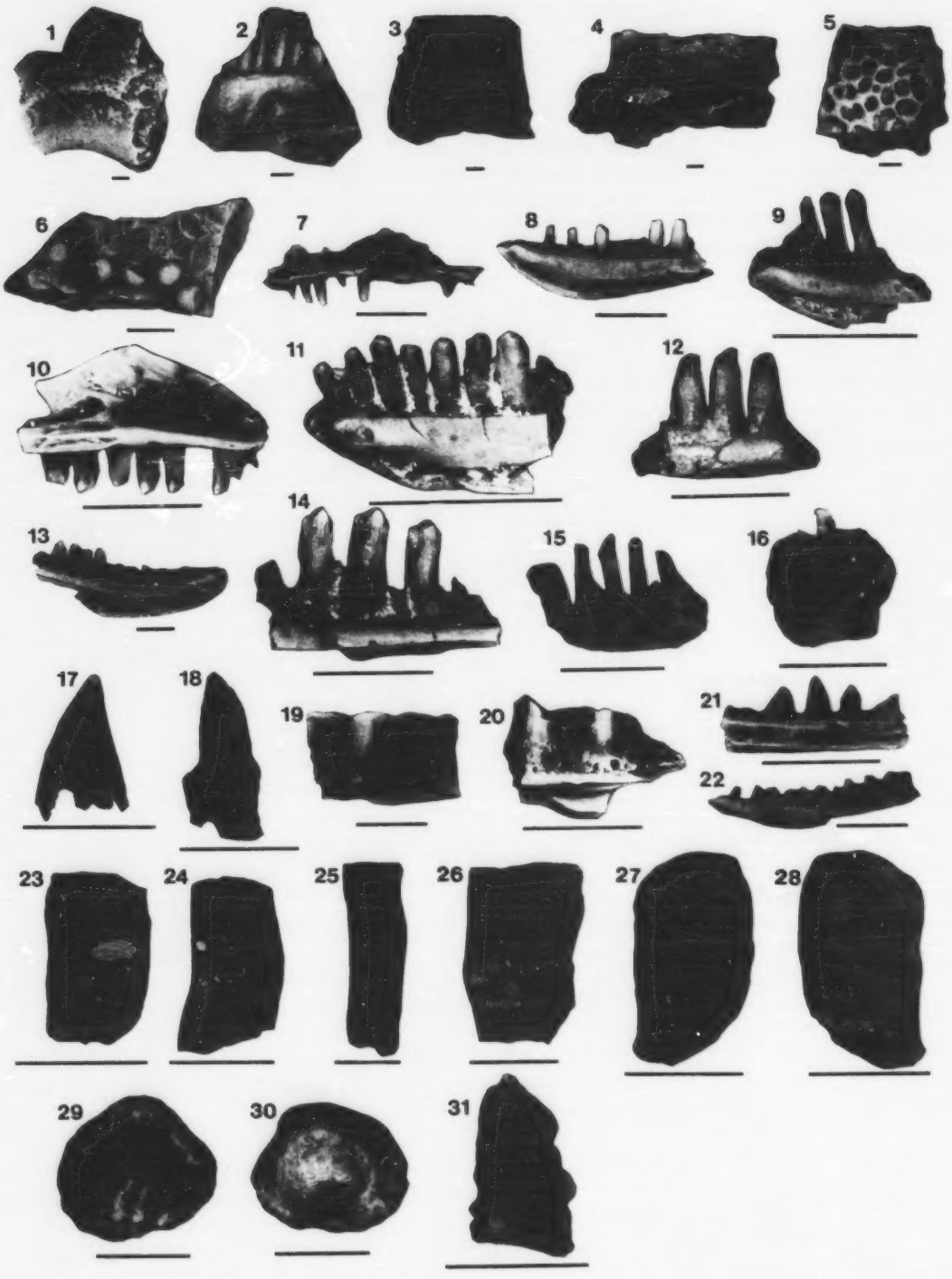
Material. Shell fragments (RTMP96.79.45-63).

Description and Discussion. These shell fragments are diagnostic in being heavily built, smooth and devoid of shell sculpture, and in the presence of shallow sulci. Three genera of baenids, *Plesiobaena*, *Boremys*, and *Neuranchelys*, have been reported from the upper Cretaceous deposits of southern Alberta (e.g., Gaffney 1972), but the material recovered in the present study is too fragmentary to be identified at the generic level.

Family CHELYDRIDAE Agassiz, 1857
Genus and species indet.
Plate 6, figure 2

Material. Shell fragments (RTMP96.79.28-43)

Description and Discussion. Chelydrid shell fragments are identifiable on the basis of a thin shell and the presence of deep sulci, prominent ridges, and corrugations on the carapace. Isolated peripheral bones (RTMP96.79.36) are distinctive in bearing deep sulci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and deep pits for articulation with the ribs. These chelydrid specimens are noticably smaller than most of the other turtle specimens from the same microsites.

Chelydrid specimens have been reported from the Lance Formation of Wyoming and referred to 'Chelydridae gen. indet.' (Estes 1964; Hutchison and Archibald 1986). According to Hutchison and Archibald (1986), these specimens, represented by disarticulated shell fragments, were mistakenly referred by Estes (1964) to "the Emydidae near *Pseudemys*". Evidently, the chelydrid material recovered in the present study shows resemblance to that from the Lance Formation and is thus referred to that taxon. Similar material of chelydrids has also been reported from the Judith River Group of DPP (Brinkman 1990).

Emarginochelys cretacea, based on an articulated skeleton from the Hell Creek Formation of Montana, was originally described by Whetstone (1978) as a chelydrid, but is now recognized to be a kinosternoid turtle (Meylan and Gaffney 1989).

Family ADOCIDAE Cope, 1870
Genus ADOCUS Cope, 1868
Adocus sp.
Plate 6, figure 3

Material. Shell fragments, catalogued as RTMP96.79.20-27.

Description. These specimens are characteristic in bearing very fine ornamentation on the shell fragments. Such ornamentation is comprised of numerous shallow pits bounded by low ridges in a regularly arranged series of lines, also referred to as punctate sculpturing (Meylan and Gaffney 1989). This contrasts with the shell ornamentation of trionychids, which consists of deep pits and high, wavy ridges.

Discussion. The osteology of *Adocus* was well documented by Meylan and Gaffney (1989) on the basis of a nearly complete skeleton from the Hell Creek Formation of Montana. Shell fragments of *Adocus*, readily identifiable based upon their distinct punctate sculpturing, have been recovered in great abundance from upper Cretaceous deposits of North America. Further specific identification based upon shell sculpture pattern within this genus, however, has been the subject of debate (Brown 1907; Gilmore 1919; White 1972).

Estes *et al.* (1969) noted that two types of *Adocus* shell sculpture are typical of the late Cretaceous specimens: a very fine type with eight to ten pits per centimetre, and a more well defined type with six to seven pits per centimetre. They found that all the Hell Creek specimens exhibited the former type, and thus suggested that the two sculpture patterns are not simply variants indicative of different shell areas. However, the specimens recovered from the microsites examined in this study reveal that the number of pits varies from five to ten per centimetre. Some fragments of peripheral bones also

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PLATE 6. Fig. 1. Baenidae genus and species indet. Shell fragment (RTMP96.79.45) in external view. **Fig. 2**. Chelydridae gen. indet. Costal fragment (RTMP96.79.41) in external view. **Fig. 3**. *Adocus* sp. Carapace fragment (RTMP96.79.20) in external view. **Fig. 4.** *Basilemys* sp. Peripheral fragment (unaccesioned specimen) in external view. **Fig. 5.** Trionychidae genus and species indet. Carapace fragment (RTMP96.79.1) in external view. **Fig. 6.** *Naomichelys* sp. Carapace fragment (RTMP96.79.44) in external view. **Figs. 7-9.** *Socognathus unicuspis*. Right maxilla (RTMP96.74.3a): **7**, medial view. Right dentaries in medial view: **8**, (RTMP96.74.3c); **9**, (RTMP96.74.4). **Figs. 10-14.** *Leptochamops* sp. Right maxilla (RTMP96.74.16): **10**, medial view. Jaw elements: **12**, lateral view (RTMP96.74.16); **14**, (RTMP96.74.16). Right dentary (RTMP96.74.15): **11**, medial view. **Fig. 13**. *Gerontoseps irvinensis*. Left dentary (RTMP96.74.19) in medial view. **Figs. 15, 16.** *Odaxosaurus* sp. cf. *O. priscus*. Left dentary (RTMP96.74.26): **15,** medial view. Jaw element (RTMP96.74.25): **16**, partial. **Fig. 17.** cf. *Palaeosaniwa canadensis*. Marginal tooth (RTMP96.74.42) in lateral view. **Fig. 18.** cf. *Paraderma bogerti*. Marginal tooth (RTMP96.74.37) in medial view. **Fig 19, 20.** Varanoidea fam. indet. Jaw elements in medial view: **19**, (RTMP96.74.71); **20**, (RTMP96.74.72). **Figs. 21-22.** *Colpodontosaurus* sp. cf. *C. cracens*. Left dentary (RTMP96.74.24b): **21**, lateral view. Right dentary (RTMP96.74.24a): **22**, medial view. **Figs. 23-26.** cf. *Odaxosaurus piger* Osteoscutes in external view: **23**, (RTMP96.74.30); **24**, (RTMP96.74.31); **25**, (RTMP96.74.33); **26,** (RTMP96.74.36). **Figs. 27-30.** Helodermatidae genus and species indet. Elongate osteoderms (RTMP96.74.60): **27**, external; **28**, internal view. Round osteoderm (RTMP96.74.62): **29**, internal; **30**, external view. **Fig. 31.** Xenosauridae genus and species indet. Half complete osteoderm (RTMP96.74.67) in external view. **Scale bars for all Figures = 2mm.**

reveal that the pits of the sculpture on the ventral side are relatively larger and more laterally elongate than those on the dorsal side. Thus, the variation that Estes *et al.* (1969) noted is likely a result of variation on the shell of a single species.

Adocus was considered by Estes and Berberian (1970) to be restricted to Maastrichtian strata. Recent work has indicated that it has a wider temporal and stratigraphic range of distribution in southern Alberta, including the upper Milk River Formation (Peng unpublished), the Foremost and Oldman formations (this study), and the Dinosaur Park Formation (Brinkman 1990).

Family NANHSIUNGCHELYIDAE Yeh, 1966
Genus BASILEMYS Hay, 1902
Basilemys sp.
Plate 6, figure 4

Basilemys sp. Russell 1935, 1964; Sahni 1972; Brinkman 1990.

Material. Shell fragments, known only from surface-collected samples from WS.

Description and Discussion. Shell fragments of *Basilemys* can be readily identified by their rough, coarse sculpture with only three to four pits per centimetre, in contrast to that of *Adocus* which is relatively fine, smooth, and has more than five pits per centimetre (e.g., Estes *et al.* 1969). *Basilemys* shell fragments are also distinguishable from other turtles known from the upper Cretaceous in their considerable thickness (e.g., Sahni 1972). *Basilemys* material recovered in this study is very similar to that from DPP (Brinkman 1990).

Family TRIONYCHIDAE Gray, 1870
Genus and species indet.
Plate 6, figure 5

Material. Shell fragments (RTMP96.79.1-19).

Description and Discussion. Trionychid specimens can be readily recognized on the basis of their distinctive shell sculpture patterns. These patterns vary from numerous pits of various shapes encompassed by irregular and rounded ridges, to arrays of many grooves segregated by wavy ridges. Such ornamentation has been widely considered to be characteristic of the family Trionychidae, but it has been considered to be of dubious taxonomic significance at lower taxonomic levels (Estes 1964; Nicholls 1972; Gaffney 1979; Gardner and Russell 1994). Gardner and Russell (1994) noted that the sculpture patterns of trionychids are irregular and that they may vary within an individual shell and also probably during ontogeny. Recently, Gardner *et al.* (1995) documented trionychid fossils from the Judith River Group of North America, and concluded that only two genera (*Aspideretoides* and *Apalone*) and four species are valid after reviewing three genera and 15 nominal species of trionychids that had previously been described. Sculpture pattern on the dorsomedian carapace is listed by Gardner *et al.* (1995) as one of the diagnostic features of the three species of *Aspideretoides*. Nevertheless, the shell material recovered in the present study is too fragmentary to be assigned with certainty to the generic level.

Family *incertae sedis*
Genus NAOMICHELYS Hay, 1908
Naomichelys sp.
Plate 6, figure 6

Material. A single shell fragment (RTMP96.79.44) of this taxon was retrieved, from PHR-1, by screen-washing.

Description and Discussion. *Naomichelys* shell material is very distinctive in bearing numerous, pillar-like tubercles on the dorsal surface, which makes it easily distinguishable from other turtles. This genus first occurs in the lower Cretaceous (Hay 1908). The recovery of this genus from site PHR-1 (the upper Foremost Formation) represents, to date, its most recent stratigraphic occurrence. This may indicate that *Naomichelys* became extinct in the time period represented by the Foremost Formation. Surface collecting in the present study has indicated that *Naomichelys* material is present in the lower portion of the Foremost Formation.

Subclass DIAPSIDA Osborn, 1903
Infraclass LEPIDOSAUROMORPHA Benton, 1983
Superorder LEPIDOSAURIA Haeckel, 1866
Order SQUAMATA Oppel, 1811
Suborder LACERTILIA Owen, 1842

Fossil lacertilian material is well known from the upper Cretaceous of North America (e.g., Gilmore 1928; Estes 1964, 1983; Gao and Fox 1991). Recently Gao and Fox (1996) extensively documented the lacertilians of the late Cretaceous, especially

those from the Judith River Group of southern Alberta. Abundant lacertilian material was recovered from the microsites examined in the present study. In the following descriptions of these specimens, the taxonomic and morphological terms applied by Gao and Fox (1996) have been adopted, except where noted.

Infraorder SCINCOMORPHA Camp, 1923
Family TEIIDAE Gray, 1827
Genus SOCOGNATHUS Gao and Fox, 1991
Socognathus unicuspis Gao and Fox, 1991
Plate 6, figures 7-9

Socognathus unicuspis Gao and Fox 1991:146, pl. 3, figs. 1-8, text-fig. 7; Gao and Fox 1996:25, figs. 8-9.

Material. Specimens referable to this taxon are: RTMP96.74.1, an incomplete dentary (Ho S); RTMP96.74.2, a fragmentary dentary (PHS); RTMP96.74.3a-c, one nearly complete right maxilla, a partial left maxilla and a dentary (CS); RTMP96.74.4, jaw fragments (PLS).

Description. *Socognathus* dentaries are identifiable on the basis of their strong mandibular symphysis that bears a well developed ventral buttress, and their teeth that are subpleurodont and unicuspid, with the cusp being pointed and posterolingually inclined. This cusp is always flanked by a strong anterior ridge and a weak posterior one, with faint striations present on the lingual face of the cusp between the anterior and posterior ridges. A nearly complete right maxilla (RTMP96.74.3a, fig. 12-1) shows overall similarity to those (UALVP 29910-11) described by Gao and Fox (1996, figs. 9D-E). This specimen (RTMP96.74.3a) bears somewhat anteroposteriorly compressed anterior teeth. The completely preserved 12th tooth, however, lacks this morphology and is short. The premaxillary process of the maxilla is short, and dorsally bears a medially extended and concave surface that forms the floor of the external naris. The nasal process of the maxilla is partially preserved, and its interior surface differs from that of *Chamops*, a teiid described from the Lance Formation of Wyoming (e.g., Estes 1964), in that the two depressions described by Gao and Fox (1996) are less distinctly separated from one another. A partial left maxilla (RTMP96.74.3b) was also recovered from the same microsite (CS) as RTMP96.74.3a. The two are almost mirror images of each other in morphology and also are very similar in size, and thus may be from the same individual.

Discussion. *Socognathus unicuspis* was described by Gao and Fox (1991) on the basis of incomplete dentaries and maxillae from the upper Judith River Group of southern Alberta. Such material has not been positively identified from any other deposits so far. The specimens recovered in the present study represent the earliest stratigraphic occurrence of this taxon.

Genus LEPTOCHAMOPS Estes, 1964
Leptochamops sp.
Plate 6, figures 10-12,14

Material. Specimens referred to *Leptochamops* are: RTMP96.74.5, a partial dentary (PHR-1); RTMP96.74.6, a right partial dentary (PHR-2); RTMP96.74.7, three dentary fragments (WS); RTMP96.74.8, four dentary fragments (EZ); RTMP96.74.9, three dentary fragments (PHR93-2); RTMP96.74.10, a dentary fragment (Sal S); RTMP96.74.11, four jaw fragments (HS); RTMP96.74.12, three jaw fragments (HAS); RTMP96.74.13, two jaw fragments (CN-1); RTMP96.74.14, two jaw fragments (CN-2); RTMP96.74.15, four partial dentaries (ORS); RTMP96.74.16, seven fragmentary jaw elements (CBC); RTMP96.74.17, a partial left dentary (RDS); and RTMP96.74.18, four jaw fragments (BMC).

Description. The tooth-bearing specimens of this taxon can be identified on the basis of their characteristic tooth morphology: high-crowned, slender, cylindrical and tricuspid. Among the specimens referred, RTMP96.74.18 (a right dentary from BMC) is the best preserved, despite the absence of a small segment from its middle, and a broken posterior end. It bears 10 complete teeth, which are incipiently tricuspid anteriorly and typically tricuspid posteriorly. All the teeth are closely spaced. The subdental shelf is robust anteriorly and gradually thins dorsoventrally posterior to the 7th tooth, and it exhibits a slight upward curvature at each end. The anterior end reveals that the mandibular symphysis was weak, lacking the well developed ventral buttress that is evident in the dentary of *Socognathus*.

Discussion. Two nominal species of *Leptochamops* have been described: *L. denticulatus* and *L. thrinax*. *L. denticulatus* was initially described from the Lance Formation of Wyoming (Gilmore 1928; Estes 1964), and subsequently specimens from the Hell

Creek Formation of Montana (Estes *et al.* 1969), and the Frenchman Formation and the upper Judith River Group of southern Alberta (Gao and Fox 1996) were referred to this species. *L. thrinax* was described by Gao and Fox (1991) on the basis of dentaries from the upper Judith River Group of southern Alberta. It is considered to be separable from *L. denticulatus* on the basis of dentary teeth that are more robust, more widely spaced and fewer in number, and a straighter subdentary shelf. RTMP96.74.18, as described above, resembles UALVP29772 (Gao and Fox 1996, fig. 16E) in tooth morphology, and both of these specimens differ from *L. thrinax* in that the subdental shelf curves upwards on both anterior and posterior ends, and that the teeth are closely spaced. Interestingly, RTMP96.74.18 reveals the presence of striations on the lingual side of the crown apices, a condition unknown for either of the nominal species so far described. Comparable lingual striations were noted by Denton and O'Neill (1995) on teiid teeth described from the upper Cretaceous Marshalltown Formation of New Jersey (Denton and O'Neill 1995, fig. 3). The presence of lingual striations was interpreted by Denton and O'Neill (1995) to be a derived character shared by *Chamops* and *Prototeius*, but the striations on *Chamops* were later argued, by Gao and Fox (1996), to be due to individual variation. The presence of lingual striations on the specimens described here suggests that this feature is widely shared by upper Cretaceous teiids and that the absence of such striations on some specimens may be due to tooth wear. Additional study is needed to clarify this. The specimens of dentaries referable to *Leptochamops* are, however, too fragmentary to enable more precise identification, and they are thus referred to *Leptochamops* sp.

Genus GERONTOSEPS Gao and Fox, 1991
Gerontoseps irvinensis Gao and Fox, 1991
Plate 6, figure 13

Gerontoseps irvinensis Gao and Fox 1991:149, pl. 5, figs. 1-4, text-fig. 10; Gao and Fox 1996:34, figs. 13, 14A-D.

Material. RTMP96.74.19, a nearly complete left dentary from the PLS site.

Description. This dentary is referable to *Gerontoseps irvinensis* on the basis of the following features: a shallow element with a narrow but deep *sulcus dentalis*; subpleurodont, unicuspid teeth, with symmetrical anterior and posterior crests. This dentary (RTMP96.74.19) is similar to UALVP29760-61 (Gao and Fox 1996, figs. 14C-D) in that the splenial is not fused to it, although an articular facet is evident along the posterior and posteroventral side of the subdental shelf. RTMP96.74.19 still carries the 15 anteriormost teeth, of which four are complete.

Discussion. *G. irvinensis* has been reported only from the upper Judith River Group of Alberta (Gao and Fox 1991, 1996). Although RTMP96.74.19 is the only specimen of this taxon recovered in this study, it represents the first record of this taxon outside the type locality and from a relatively lower stratigraphic section. This specimen also supports the interpretation of Gao and Fox (1996) that the fusion of the splenial with the dentary along their dorsal contact represents ontogenetic variation, rather than being a diagnostic feature of the taxon, as previously stated (Gao and Fox 1991).

Infraorder ANGUIMORPHA Fürbringer, 1900
Family ANGUIDAE Gray, 1825
Genus ODAXOSAURUS Gilmore, 1928
Odaxosaurus sp. cf. *O. priscus* Gao and Fox, 1996
Plate 6, figures 15-16

Odaxosaurus priscus Gao and Fox 1996:70, figs. 29, 30A-F.

Material. RTMP96.74.25, incomplete right dentaries (RDS); RTMP96.74.26, a left partial dentary (CS).

Description. All three dentaries are referable to *Odaxosaurus* on the basis of their tooth morphology. The dentary teeth are characteristic in being strongly compressed anteroposteriorly and transversely elongate and rectangular in cross section, and in possessing a truncate crown with a horizontal cutting edge. A right dentary (RTMP96.74.25a) bears three teeth that are closely spaced, the middle one complete and the other two missing the crown tips. The teeth are pleurodont, and each has a basal foramen on the lingual side. The complete tooth reveals that the crown is similar to that of *O. priscus* (Gao and Fox 1996), and is less extensively truncated than that of *O. piger*. No striations are evident on the medial face of the crown. According to Gao and Fox (1996), the teeth of *O. priscus* bear weak striations. A second dentary (RTMP96.74.25b), bearing nine consecutive teeth with broken crowns, reveals that the teeth are closely spaced, and that the *sulcus dentalis* is absent.

The third dentary (RTMP96.74.26) is smaller and bears four teeth that are also closely spaced, one being complete. The cutting edge of the complete crown is absent, apparently the result of wear.

Discussion. *O. piger* was initially described from material from the Lance Formation of Wyoming (Gilmore 1928). Material referred to the taxon has also been reported from the Hell Creek Formation of Montana, the Laramie Formation of Colorado (Carpenter 1979), and the Scollard and the Frenchman formations of Alberta (Gao and Fox 1996). The second species of the genus, *O. priscus*, was erected by Gao and Fox (1996) on the basis of material from the upper Judith River Group of Alberta. *O. priscus* is, according to Gao and Fox (1996), different from *O. piger* as the dentary tooth count is lower due to wider spacing of the teeth, and the crown is less strongly truncated and less heavily striated medially. The three dentaries recovered in this study resemble those of *O. priscus* in the presence of a less strongly truncated crown, but they also reveal that the teeth are closely spaced, which is different from the condition found in *O. priscus*, but similar to that of *O. piger*. Moreover, it is evident that the maxillae referred to *O. priscus* by Gao and Fox (1996) have closely spaced teeth. Therefore, the closely spaced dentary teeth exhibited by UALVP29896 and 29897 (Gao and Fox 1996, figs.30A-B) could be the result of individual variation. Such a feature is not a good diagnostic character for the species on the basis of what is currently known. Nevertheless, the dentaries recovered in this study are tentatively referable to *O. priscus* on the basis of their similarity of tooth crown structure. They apparently represent, to date, the earliest stratigraphic occurrence of *Odaxosaurus*.

cf. *Odaxosaurus piger* (Gilmore, 1928)
Plate 6, figures 23-26

Peltosaurus piger Gilmore 1928:136, pl. 26, figs. 4, 6; Sahni 1972:354, figs. 8G-H; Estes 1964:121, fig. 57b.
Odaxosaurus obliquus Gilmore 1928:158, pl. 28, figs. 3, 5.
Pancelosaurus piger Meszoely 1970:105.
Odaxosaurus piger Breithaupt 1982:136; Gao and Fox 1996:68, fig. 28.

Material. Isolated osteoscutes (RTMP96.74.27-36)

Description. All of these osteoscutes are basically rectangular, with the length exceeding the width. Each possesses an anterior gliding surface which, in life, was overlapped by another osteoscute lying anterior to it; and an exposed, posterior surface that is sculptured with irregular pits and ridges. The two extremities are separated by a groove. The smooth gliding surface varies from about one-third to one-half of the length of the osteoscute. There is no evidence of suturing along the lateral edges. Two different types of osteoscute are recognizable among the material recovered. The first is smooth, and typically has lateral edges that bear smooth, oblique surfaces, one facing dorsally and the other ventrally. This suggests that they provide for lateral overlapping of adjacent osteoscutes. Such osteoscutes evidently represent those of the flanks (Meszoely 1970, 1973). The second is larger and thicker, and bears a prominent median keel on the exposed surface. The smooth lateral surfaces both face either lateroventrally or laterally, indicating that this type of osteoscute overlapped adjacent ones. They are evidently representative of mid-dorsal osteoscutes (Meszoely 1970).

Discussion. These osteoscutes show a great resemblance to those of *Odaxosaurus* (Estes 1964; Meszoely 1970) in their general constitution and in the sculpturing of the exposed surfaces. The mid-dorsal osteoscutes recovered in this study, however, differ in that a median ridge is prominent, contrasting with those of *Odaxosaurus piger* in which no median keel is present (Meszoely 1970). Gao and Fox (1996) described a second species of *Odaxosaurus*, *O. priscus*, on the basis of dentaries from the upper Judith River Group of Alberta (see above). Similar specimens were recovered from the microsites examined in this study, from which these osteoscutes were also retrieved. The different mid-dorsal body osteoscutes, when compared to those of *O. piger*, are further suggestive of the presence of a second species of *Odaxosaurus*.

Family NECROSAURIDAE Hoffstetter, 1943
Genus COLPODONTOSAURUS Estes, 1964
Colpodontosaurus sp. cf. *C. cracens* Estes, 1964
Plate 6, figures 21-22

Colpodontosaurus cracens Estes 1964:128, fig. 60; Estes *et al.* 1969:20; Gao and Fox 1996:74, figs. 31A-C.

Material. RTMP96.74.20, three partial dentaries from site SPS; RTMP96.74.21, a right partial dentary from site Ho S; RTMP96.74.22, a left dentary and

two partial maxillae from site WS; RTMP96.74.23, a dentary fragment and a partial maxilla from site CN-1; and RTMP96.74.24, a right and a left dentary from site ORS.

Description. RTMP96.74.24a is the most nearly complete dentary, missing only small portions of the anterior and posterior ends. It is slender, and similar in general form to those typical of *Colpodontosaurus* (see Estes 1964, fig. 60; Gao and Fox 1996, fig. 31B). It differs, however, in that the tooth row curves strongly upward at both ends. The subdental shelf is relatively well developed, thicker anteriorly and gradually thins toward the posterior end. The *sulcus dentalis* is very shallow anteriorly and is absent in the posterior half of the dentary. The intramandibular septum is poorly developed. This dentary bears 10 complete or nearly complete teeth, and four tooth bases. These teeth are low-crowned and constricted at their tip, with expanded bases and a thin tooth wall, which are all typical of *Colpodontosaurus* teeth. The complete teeth all exhibit essentially straight shafts without recurved tips, in contrast to those of the holotype of the type species of the genus (see Estes 1964, fig. 60), which has strongly recurved crown tips. Another specimen (RTMP96.74.24b) from the same site (ORS) (the posterior portion of a left dentary) carries three complete teeth and two tooth bases, all of which have straight shafts, without recurved tips. Four large, round basal foramina are present on the lingual side. The teeth with broken crowns reveal that they are hollow and that the tooth wall is thinner labially than lingually. Such a thin tooth wall is also found in RTMP96.74.21, RTMP96.74.23a, b and RTMP96.74.24a. Two partial dentaries (RTMP96.74.20a, b) bear three and two complete teeth, respectively. These teeth are generally similar to those of the specimens described above, but differ in that the crown is taller and is comparatively less strongly constricted. They are similar to the teeth of *Litakis gilmorei* (Estes 1964) in having relatively high crowns. According to Estes (1964), the teeth of *L. gilmorei* are, however, different in having anterior and posterior ridges, resulting in an incipiently tricuspid appearance. Thus, these dentaries (RTMP96.74.20a, b) are still referred to *Colpodontosaurus* on the basis of their expanded tooth bases and the presence of a poorly developed intramandibular septum.

Three incomplete maxillae (RTMP96.74.22b-c and RTMP96.74.23b) are assigned to this taxon on the basis their tooth morphology, which is very similar to that of the dentary teeth described above.

Discussion. *Colpodontosaurus cracens* was previously known only from Maastrichtian deposits, including those of the Lance Formation of Wyoming, the Hell Creek Formation of Montana, and the Scollard Formation of Alberta (Estes 1964, 1983; Estes *et al.* 1969; Gao and Fox 1996). The specimens recovered in this study are referable to *Colpodontosaurus* on the basis of the following features: dentary slender, with a poorly developed intramandibular septum; teeth low-crowned and thinly walled, with the base expanded and lacking striations. They also represent, for the first time, specimens with complete and numerous teeth. The recurved crown tips of the holotype were reconstructed by Estes (1964). Gao and Fox (1996) noted that the teeth of UALVP29782 have a relatively straight shaft and that a slightly recurved tip is present on the single, nearly complete tooth. All the specimens recovered in this study clearly show that the teeth have a straight shaft and lack recurved crown tips. They also represent the first record of *Colpodontosaurus* from the Judith River Group of Alberta.

Family HELODERMATIDAE Gray, 1837
Genus PARADERMA Estes, 1964
cf. *Paraderma bogerti* Estes, 1964
Plate 6, figure 18

Paraderma bogerti Estes 1964:132, figs. 64-65; Gao and Fox 1996:82, figs. 34-35.

Material. RTMP96.74.37, a complete marginal tooth (PHS), RTMP96.74.38, a nearly complete tooth (BMC) and RTMP96.74.39, a marginal tooth (CS).

Description. RTMP96.74.37 is laterally compressed but rather robust. The crown is straight and strongly trenchant, with a slightly recurved tip. Both the anterior and posterior cutting edges are sharp, but lack serrations. A shallow venom groove is evident extending from the base along the anterior cutting edge close to the tip. Such a groove is not present along the posterior edge. The tooth base is moderately expanded lingually, and bears infoldings on its surface. A basal foramen is evident at the bottom of the base on the lingual side. It is not clear whether RTMP96.74.37 is a dentary or maxillary tooth.

Discussion. All three teeth (RTMP96.74.37-39) are comparable to those of *Paraderma bogerti* (Estes

1964; Gao and Fox 1996) in their general shape, and especially in the presence of a shallow venom groove along the anterior edge. In *Labrodioctes*, another helodermatid from the Judith River Group described by Gao and Fox (1996), the venom groove is absent on the anterior edge but present on the posterior edge. Although Gao and Fox (1996) questioned the reported occurrence (Sahni 1972) of this taxon in the Judith River Group and considered it to be restricted to the deposits of the Lance Formation, the specimens recovered in this study confirm its occurrence in the Judith River Group of southern Alberta.

Family HELODERMATIDAE Gray, 1837
Genus and species indet.
Plate 6, figures 27-30

Material. Isolated osteoderms (RTMP96.74.52-65).
Description. These osteoderms range in maximum length from 1.5 mm to 6 mm. They are readily distinguishable from other lizard osteoderms in being thick and heavily constructed. They possess an outer surface that is slightly concave and highly tuberculate, and an inner surface that is convex, smooth and endowed with markings that probably represent growth rings. Two distinctive types of osteoderms are present: one is generally oval-shaped and small; the other is rectangular or subrectangular, and larger. They are interpreted as regional variants within individuals.
Discussion. These isolated osteoderms are comparable to those of helodermatids (e.g., *Heloderma texana*, Stevens 1977), in being thick and robust, and in bearing a tuberculate outer surface. They cannot be referred to either of the two known helodermatids from the Judith River Group. Thus, they are here referred to as Helodermatidae genus and species indet. Such helodermatid osteoderms represent the first report of this taxon from the upper Cretaceous of North America, although similar material has also been recovered from the Judith River Group of DPP.

Family XENOSAURIDAE Cope, 1886
Genus and species indet.
Plate 6, figure 31

Material. Isolated osteoderms (RTMP96.74.66-67).
Description and Discussion. These osteoderms are transversely elongate, wedge-shaped, slenderly built elements. A prominent ridge is present on the external surface, extending between the two pointed ends and dividing the surface into an anterior and a posterior facet. Both anterior and posterior surfaces incline toward the ridge. The external surface is sculptured with small pits, while the interior surface lacks sculpture and is flat. They are readily distinguishable from the osteoderms of helodermatids in their different shape, in lacking tuberculate ornamentation, and in their slender construction. An isolated xenosaurid frontal with fused osteoderms was described by Gao and Fox (1996) from the Judith River Group in DPP but was referred only to the family.

Family VARANIDAE Gray, 1827
Genus PALAEOSANIWA Gilmore, 1928
cf. *Palaeosaniwa canadensis* Gilmore, 1928
Plate 6, figure 17

Palaeosaniwa canadensis Gilmore 1928:83; Estes 1964:135, fig. 66; Gao and Fox 1996:90, figs. 37-38.
Megasaurus robustus Gilmore 1928:157, pl. 27, figs. 1, 1a.

Material. All referable specimens are isolated marginal teeth, and are catalogued as RTMP96.74.40-51.
Description. These isolated marginal teeth have evidently been shed, as indicated by the presence of a large pit at the attachment end (resulting from resorption in the process of replacement) and the missing crown base. The crown length of these teeth ranges from about 2 mm to 4 mm. They are laterally compressed and trenchant, with sharply pointed tips. Both the anterior and posterior edges bear microserrations. The whole tooth surface is coated with a layer of shiny enamel. No venom grooves are evident on any teeth.
Discussion. These marginal teeth resemble the isolated teeth of *Palaeosaniwa canadensis*, described by Estes (1964), in general shape, and in the presence of microserrations on the anterior and posterior cutting edges. Gao and Fox (1996) described some jaw fragments from the Judith River Group of southern Alberta, and referred them to *P. canadensis*. They suggested that the microserrations on the teeth that they described are slightly different from those illustrated by Estes (1964, fig. 66) from the Lance Formation of Wyoming. Such a difference is not evident on the isolated teeth recovered in the present study.

Superfamily VARANOIDEA Camp, 1923
Family indet.
Plate 6, figures 19-20

Material. Fragments of jaw elements (RTMP96.74.68-75).

Description and Discussion. These specimens are mostly partial dentaries with broken tooth crowns. They are referred to the Varanoidea primarily on the basis of the presence of the infolded crown bases, as well as the absence of a subdental shelf. Nevertheless, they are too incomplete to allow further taxonomic assignment.

Division ARCHOSAUROMORPHA Huene, 1946
Order CHORISTODERA Cope, 1876
Family CHAMPSOSAURIDAE Cope, 1876
Genus CHAMPSOSAURUS Cope, 1876
Champsosaurus sp.
Plate 7, figures 6, 8-10

Material. Specimens referred to this taxon include fragments of jaws, isolated teeth and centra, catalogued as RTMP96.73.54-93.

Description and Discussion. Jaw fragments (RTMP96.73.73-82) are represented mainly by dentaries. They are robustly built and are often preserved with their teeth attached. The crowns of most of these teeth are broken, leaving only the bases. As a result, the acrodont mode of tooth attachment is evident, and a large pulp cavity is revealed in the base of each tooth. Isolated teeth (RTMP96.73.54-72) are slender, cone-shaped, and bear faint striations. Some carry anteroposterior keels on the crowns. They can be confused with those of isolated *Atractosteus* teeth, which are similar in both form and size. *Atractosteus* teeth are, however, different in that they have a translucent tip and a prominent neck between the tip and the crown.

Isolated champsosaur centra (RTMP96.73.83-93) are predominately representative of the presacral region, but a few caudals have also been retrieved. The largest measures 20 mm long and the smallest 4 mm. They are amphiplatyan and cylindrical, as is typical of champsosaurids.

Subdivision ARCHOSAURIA Cope, 1869
Order CROCODYLIA Gmelin, 1788

Crocodylian fossil remains from late Cretaceous North America have been well described and documented from abundant specimens (e.g., Gilmore 1911; Erickson 1972; Norell *et al.* 1994; Wu *et al.* 1996). Isolated teeth and scutes represent all the identified specimens retrieved in the present collection.

Family CROCODYLIDAE Cuvier, 1808
Genus LEIDYOSUCHUS Lambe, 1907
Leidyosuchus sp.
Plate 7, figures 1-2, 6

Material. Specimens of *Leidyosuchus* recovered are represented by isolated teeth and scutes. They are catalogued as RTMP96.73.1-38.

Description. The isolated teeth are typical of those of the genus, with two different forms being evident: cone-shaped teeth with smooth or faint striations (the smaller ones tending to be more strongly striated); and bulbous, low-crowned teeth that are finely striated and oval in cross-section, with an evident neck at the base of the crown. The former are more abundant than the latter within the microsites examined in the present study.

Two types of scutes are also present: one has deeply pitted sculpture and is relatively thick; the other has smaller and shallower pits and a relatively thin body.

Discussion. *Leidyosuchus* is, according to Wu *et al.* (1996), the most primitive member of the Eusuchia, and material has been frequently retrieved from the upper Cretaceous of North America. The stratigraphic record of the genus includes the Judith River Group and the Edmonton Group of southern Alberta, the Judith River, the Two Medicine and the Hell Creek formations of Montana and the Lance Formation of Wyoming. Another less common non-alligatorine eusuchian, *Prodiplocynodon*, was described by Mook (1941) based on material from the Lance Formation of Wyoming. So far, no example of this taxon has been reported from the Judith River Group of Alberta or elsewhere. Thus, the material recovered in the present study is assigned to *Leidyosuchus* sp.

Subfamily ALLIGATORINAE Kälin, 1955
Genus and species indet.
Plate 7, figures 3-5

Material. Specimens referable to alligatorines consist of only isolated teeth (RTMP96.73.39-53).

Description and Discussion. Associated material of alligatorines recovered from the upper Cretaceous of North America reveals that they possessed several distinctive crushing teeth in the posterior region of the jaws (Wu *et al.* 1996). Such teeth are generally bulbous, low-crowned and laterally compressed, and are diagnostic in having wide, horizontally worn crown tips. The worn crowns indicate that the teeth were functional in the crushing actions performed by the jaws. Carpenter and Lindsey (1980) suggested that these Cretaceous alligators fed on shelled animals, such as clams and turtles. Three genera of the Alligatorinae have so far been discovered in the upper Cretaceous of North America: *Albertochampsa* from the Judith River Group of southern Alberta (Erickson 1972); *Brachychampsa* from the Hell Creek Formation of Montana (Gilmore 1911; Norell *et al.* 1994); and *Stangerochampsa* from the Horseshoe Canyon Formation of southern Alberta (Wu *et al.* 1996). The isolated alligatorine crushing teeth retrieved in this study, with their horizontally worn crowns, can be readily segregated from those of *Leidyosuchus*, which bear differently shaped, laterally worn (often to a much smaller degree) crowns associated with different feeding habits. The crushing teeth of Cretaceous alligatorines, with their horizontally worn crowns, are all similar in general form among the three known genera (Wu 1997, pers. comm.), and the isolated crushing teeth recovered in this study can only be identified as Alligatorinae genus and species indet. The non-crushing teeth of alligatorines are presumably indistinguishable from *Leidyosuchus* teeth, and are thus probably included with them.

Superorder DINOSAURIA Owen, 1842
Order ORNITHISCHIA Seeley, 1888
Suborder ORNITHOPODA Marsh, 1881
Family HADROSAURIDAE Cope, 1869

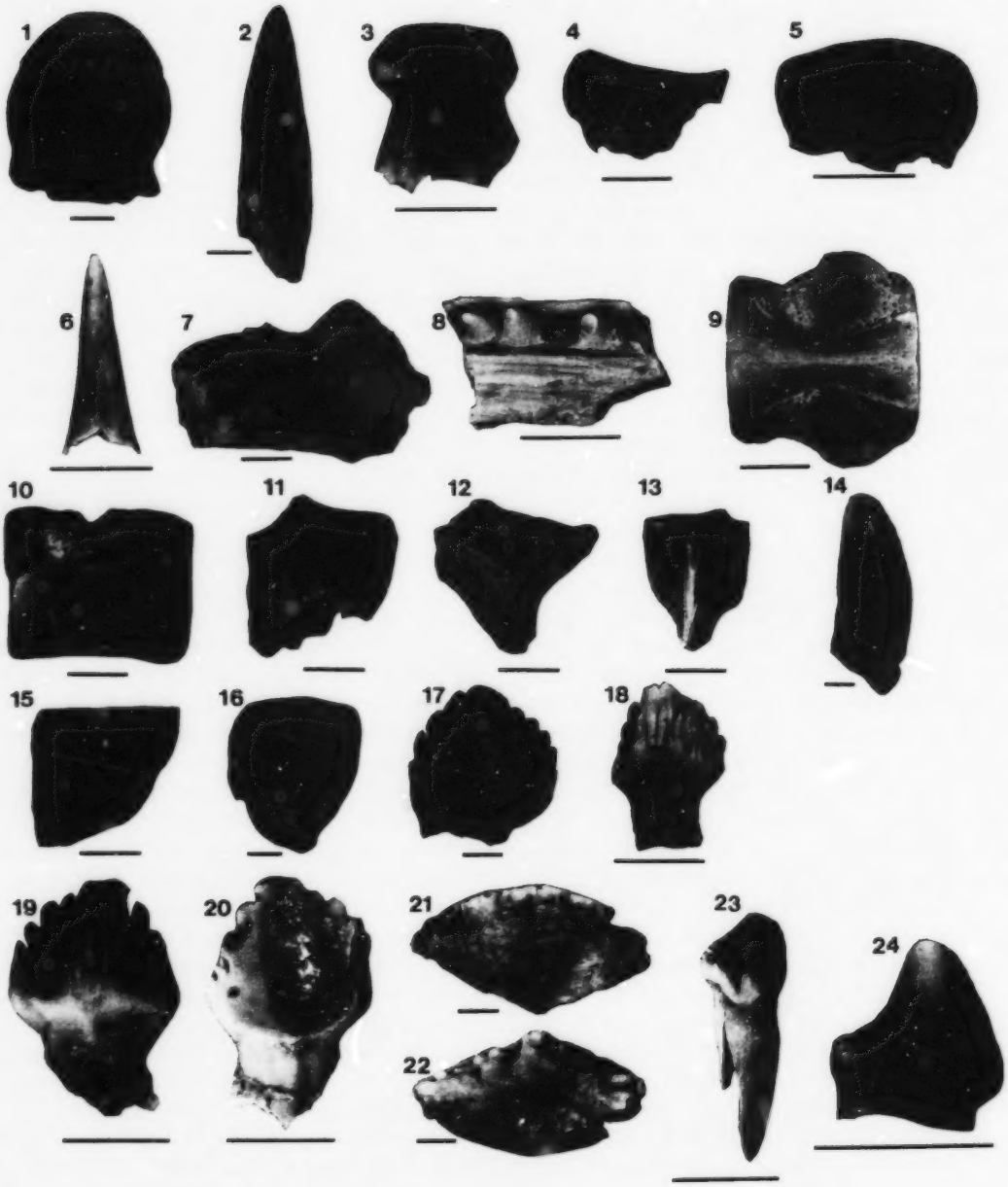
The Hadrosauridae as a monophyletic group has been widely accepted, but Horner (1990) challenged the idea and suggested that the family is of diphyletic origin. In the cladogram he presented, the Hadrosaurinae was considered to be the sister group of *Iguanodon*, while the Lambeosaurinae was considered to be the sister group of *Ouranosaurus*. Horner (1990) further argued that both subfamilies were postulated to have arisen from separate stem species and to represent two families. However, more recent phylogenetic work by Weishampel *et al.* (1993) advocates the monophyly of the family. Further, Fastovsky and Weishampel (1996) also suggested that the latter hypothesis (hadrosaurids as a monophyletic group) is more parsimonious than Horner's (1990) (hadrosaurids with separate origins). Thus, the traditional taxonomic arrangement is accepted here.

Family HADROSAURIDAE
Genus and species indet.
Plate 7, figures 11-14

Material. Specimens referable to hadrosaurids are represented by isolated teeth, most of which are functional teeth with worn crowns. They are catalogued as RTMP96. 83.1-19.

Description and Discussion. The Hadrosaurinae and Lambeosaurinae share similar forms of dentition, which are distinctive in consisting of multiple tooth families, with three to five successional teeth present at each tooth location (see Weishampel and Horner 1990, fig. 26.8). Each tooth is composed mainly of dentine, with an enamel layer present only on one side of the crown (the labial side of the maxillary teeth and lingual side of the dentary teeth—Horner 1990; Weishampel and Horner 1990). The crown of an unworn hadrosaurid tooth (RTMP96.83.16) is, on the enameled side, diamond-shaped, and its dorsoventral height is much greater than its anteroposterior width. A prominent median ridge spans the dorsoventral height of the crown face and divides it into two symmetrical halves. Most isolated teeth are represented by the majority of the crown, with a worn crown apex and broken root. These fragmentary teeth are identifiable on the basis of the presence of the median ridge and the radiating dentine deposits evident on the worn surface of the crown.

Taxonomic utility of hadrosaurid teeth has not been considered in great detail, but has been thought to be limited (Lull and Wright 1942; Gilmore 1953; Coombs 1988). Coombs (1988) stated that tooth morphology shows considerable variability within a single individual and that their morphology shows "substantial overlap among different species, genera and even subfamilies of Hadrosauridae". Nevertheless, it has also been noted that the crown morphology of the two subfamilies (Hadrosaurinae and Lambeosaurinae) is not identical. In the hadrosaurids there is a straight, median ridge, and the crown-root angle is greater than 145°, while in the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lambeosaurids there is a sinuous, median ridge, and the crown-root angle ranges between 120°-140° (Sternberg 1935; Langston 1960; Weishampel and Horner 1990). Due to the lack of roots on most of the isolated teeth recovered in the present study, it is not possible to assign them to either the Hadrosaurinae or Lambeosaurinae. Thus, they are identified as Hadrosauridae genus and species indet., on the basis of the morphology of the median ridge.

Suborder CERATOPSIA Marsh, 1890
Infraorder NEOCERATOPSIA Sereno, 1986
Family CERATOPSIDAE Marsh, 1890
Genus and species indet.
Plate 7, figures 15-16

Material. Specimens recovered here are represented by isolated tooth fragments, catalogued as RTMP96.83.20-38.

Description and Discussion. The isolated ceratopsian teeth recovered in this study are mostly functional ones, as is indicated by their greatly worn crowns. Among vertebrate microfossils recovered in the present study, they may be potentially confused with isolated hadrosaurid teeth. Ceratopsian teeth are recognizable, however, in that the dorso-ventral ridge of the crown is located in the anterior half of the occlusal surface, and secondary ridges are often present. This contrasts with the condition in hadrosaurid teeth, in which a single, median ridge is present. The worn surface of ceratopsian teeth reveals that the dentine was deposited parallel to the crown surface, not in a radiating pattern as is evident in hadrosaurid teeth. Isolated ceratopsian teeth also differ in that they bear a prominent cingulum at the base of the enameled occlusal surface. Such isolated ceratopsian teeth have been found in abundance in vertebrate microfossil assemblages of the upper Cretaceous of North America (e.g., Estes 1964; Sahni 1972; Brinkman 1990; Baszio 1997b).

Suborder ANKYLOSAURIA Osborn, 1923
Family NODOSAURIDAE Marsh, 1890
Genus and species indet.
Plate 7, figure 17

Material. Specimens referable to nodosaurids are represented only by isolated teeth (RTMP96.70.12-22)

Description and Discussion. Ankylosaurian teeth, in general, have leaf-shaped and generally labiolingually compressed crowns, with an apical cusp and secondary cusps along the crown edge. The two ankylosaurian families—Nodosauridae and Ankylosauridae (Coombs 1990; Weishampel and Horner 1990)—display significantly different tooth morphologies. Nodosaurid teeth are distinctive in being highly labiolingually compressed, in having vertical grooves that are coincident with the notches between adjacent marginal cusps on the crown flanks, and in the presence of a conspicuous basal cingulum.

Family ANKYLOSAURIDAE Brown, 1908
Genus and species indet.
Plate 7, figures 18-20

Material. Isolated teeth referable to ankylosaurids are catalogued as RTMP96.70.1-11.

Description and Discussion. The teeth of the family Ankylosauridae are generally smaller than those of nodosaurids, and differ from them in the absence of a distinct basal cingulum and in the presence of less well developed vertical grooves on the crown flanks.

PLATE 7. Figs. 1, 2. *Leidyosuchus* sp. Teeth in lateral view: **1**, (RTMP96.73.5); **2**, tooth with partial root (RTMP96.73.19). **Figs. 3-5.** Alligatorinae genus and species indet. Posterior teeth in lateral view: **3**, (RTMP96.73.47); **4**, (RTMP96.73.43); **5**, (RTMP96.73.53). **Fig. 7.** cf. *Leidyosuchus* sp. Scute (RTMP96.74.25) in external view. **Figs. 6, 8-10.** *Champsosaurus* sp. Tooth (RTMP96.73.62): **7**, lateral view. Jaw element (RTMP96.73.77): **8**, occlusal view. Trunk vertebra (RTMP96.73.83): **9**, dorsal; **10**, lateral view. **Figs. 11-14.** Hadrosauridae genus and species indet. Isolated teeth: **11**, lateral (RTMP96.83.12); **12**, occlusal (RTMP96.83.12); **13**, lateral (RTMP96.83.14); **14**, lateral view (RTMP96.83.16) (unworn tooth). **Figs. 15-16.** Ceratopsidae genus and species indet. Teeth in lateral view: **15**, (RTMP96.83.20); **16**, (RTMP96.83.21). **Fig. 17.** Nodosauridae genus and species indet. Isolated tooth (RTMP96.70.17) in labial view. **Figs. 18-20.** Ankylosauridae genus and species indet. Isolated teeth: **18**, labial (RTMP96.70.11); **19**, labial (RTMP96.70.10); **20**, lingual view (RTMP96.70.10). **Figs. 21-22.** Ankylosauria fam. indet. Isolated osteoderm (RTMP96.70.32): **21**, internal; **22**, external view. **Figs. 23-24.** Pachycephalosauridae genus and species indet. Teeth: **23**, lingual view (RTMP96.70.25) (with root); **24**, lingual view (RTMP96.70.28). **Scale bars for Figs. 1-10 = 2 mm; for Figs. 11-24 = 3 mm.**

Ankylosaurid teeth have a swollen base instead of a basal cingulum, and the vertical grooves are not in alignment with the notches between adjacent marginal cusps.

Suborder ANKYLOSAURIA
Family indet.
Plate 7, figures 21-22

Material. Specimens referable to ankylosaurians are represented by disarticulated osteoderms of the dermal armor (RTMP96.70.32-33).

Description and Discussion. The osteoderms recovered in this study are small (the greatest dimension less than 2 cm) and thus most likely represent the smaller ossifications that filled the spaces between transversely arranged rows of large armour plates (see Weishampel and Horner 1990, fig. 22.13). These small osteoderms, of a variety of shapes, can be identified on the basis of the density of the bone that constitutes them. No further information can be gleaned from them that is pertinent to a more precise taxonomic assignment. Among the microsites sampled in the present study, site CS has yielded unusually abundant isolated small osteoderms. Similar variation in abundance patterns was also noted by Brinkman (1990) among the microsites of DPP.

Suborder PACHYCEPHALOSAURIA Maryanska and Osmolska, 1974
Family PACHYCEPHALOSAURIDAE Sternberg, 1902
Genus and species indet.
Plate 7, figures 23-24

Material. Specimens referred to pachycephalosaurids are represented by only isolated teeth (RTMP96.70.23-31).

Description and Discussion. These isolated teeth are relatively small and have crowns that are triangular and labiolingually compressed, and the crown edges bear evident denticles, with the apical denticle prominently stronger than the marginals. A small, complete tooth (RTMP96.70.29) reveals that only three to four marginal denticles are present. A cingulum is well developed on the anterior and posterior portion of the teeth. A vertical ridge extends from the tip of the crown to the base and vertically divides the crown flank into two symmetrical halves. The tooth root, as shown in RTMP96.70.29 (Plate 12m), is long (about twice the crown height), but is noticeably narrower than its crown. The fully developed root and strong wear on the crown indicate that RTMP96.70.29 is a functional rather than replacement tooth, despite its rather small size (4 mm high and 1.5 mm wide).

Order SAURISCHIA Seeley, 1888
Suborder THEROPODA Marsh, 1881

Much of our current understanding of theropod dinosaur biology and diversity, particularly that of small theropods, is based upon the form and interpretation of dental material from the upper Cretaceous of North America. Currie *et al.* (1990) demonstrated that theropod teeth display diagnostic features that are distinctive at the familial, generic and even specific levels. Identification of theropod teeth in the present study is essentially based upon the descriptions provided by Currie *et al.* (1990).

Abundant theropod material has been collected from the upper Judith River Group of DPP and has been documented by Brinkman (1990) and Currie *et al.* (1990). Recently, tooth material from small theropods has been described from the Milk River Formation and the Horseshoe Canyon Formation in southern Alberta (Baszio 1997b). Although theropod teeth have occasionally been surface-collected from the lower Judith River Group (including the Foremost and Oldman formations), the theropod tooth specimens recovered from the microsites examined in this study represent the first systematic collection in this stratigraphic section of southern Alberta. This new material allows a more nearly complete documentation of theropod teeth, including variation of their morphology and patterns of their stratigraphic distribution, in the upper Cretaceous of southern Alberta.

Family DROMAEOSAURIDAE Matthew and Brown, 1922
Genus DROMAEOSAURUS Matthew and Brown, 1922
Dromaeosaurus albertensis Matthew and Brown, 1922
Plate 8, figures 1-2, 4

Dromaeosaurus albertensis Matthew and Brown 1922; Colbert and Russell 1969:66; Currie *et al.* 1990:109, fig. 8.1; Rowe *et al.* 1992:482, figs. 5G-I; Fiorillo and Currie 1994:77, fig. 3e.

Material. Isolated teeth are catalogued as RTMP96.62.1-3, and 69-70. The teeth of this genus

were encountered only relatively rarely (seven specimens) in the microsites examined in this study.

Description and Discussion. The most diagnostic feature is the anterior serration that curves off from its anterior edge near the tip of tooth (Plate 8, fig. 2). Such teeth are often strongly compressed, resulting in the cross-section being different from that of tyrannosaurid premaxillary teeth (Currie *et al.* 1990), which is typically D-shaped. Other diagnostic features, as summarized by Currie *et al.* (1990), are the denticles, that are as long as they are wide and less sharply pointed than those of *Saurornitholestes* teeth, and the size difference between anterior and posterior denticles, which is smaller than it is for the teeth of *Saurornitholestes*.

In general, the teeth of *Dromaeosaurus* can be identified by the characteristic anterior serrated ridge that deviates from the anterior edge near the tooth tip. This diagnostic feature of some *Dromaeosaurus* teeth (e.g., RTMP96.62.70), as represented in this collection, appears to be less distinctive than that seen in previously described and more typical *Dromaeosaurus* teeth, and instead appears to be more similar to that of some *Saurornitholestes* teeth (e.g., RTMP96.62.6). This type of *Dromaeosaurus* tooth can, however, still be identified as such on the basis of the presence of a less pointed and relatively straight and less recurved tip, and on the presence of labiolingually broad denticles and similarly sized anterior and posterior denticles. It is difficult to distinguish the *Dromaeosaurus* teeth in this collection from those recovered from the Milk River or DPP formations, although size variation may be present among them. Throughout the upper Cretaceous strata of southern Alberta, *Dromaeosaurus* is always a relatively rare theropod (4.32-9.47 percent of the total theropod contingent) (Currie *et al.* 1990; Baszio 1997a).

Genus SAURORNITHOLESTES Sues, 1978
Saurornitholestes langstoni Sues, 1978
Plate 8, figures 3, 5-6

Saurornitholestes langstoni Sues 1978; Currie 1987:78; Currie *et al.* 1990:110, fig. 8.2; Fiorillo and Currie 1994:77, figs. 3f-g; Rowe *et al.* 1992:482, figs. 5A-C.

Material. Isolated teeth (RTMP96.62.4-22). The teeth of *Saurornitholestes* recovered from the microsites studied here represent some of the most abundant small theropod material in this collection.

Description. The teeth of *Saurornitholestes* are most readily distinguished by the following diagnostic features: strong labiolingual compression; strongly recurved, sharply pointed tips; denticles that are chisel-like, labiolingually compressed at the base, and featuring distinctly different denticle size between the anterior and posterior denticles. Those recovered from the microsites examined in this study have anterior denticles that are either smaller than the posterior denticles or are absent. Currie *et al.* (1990) suggested that the teeth without anterior denticles might be present within the jaw, along with those with anterior denticles. The *Saurornitholestes* teeth in this collection that lack anterior denticles are interpreted as being worn replacement teeth.

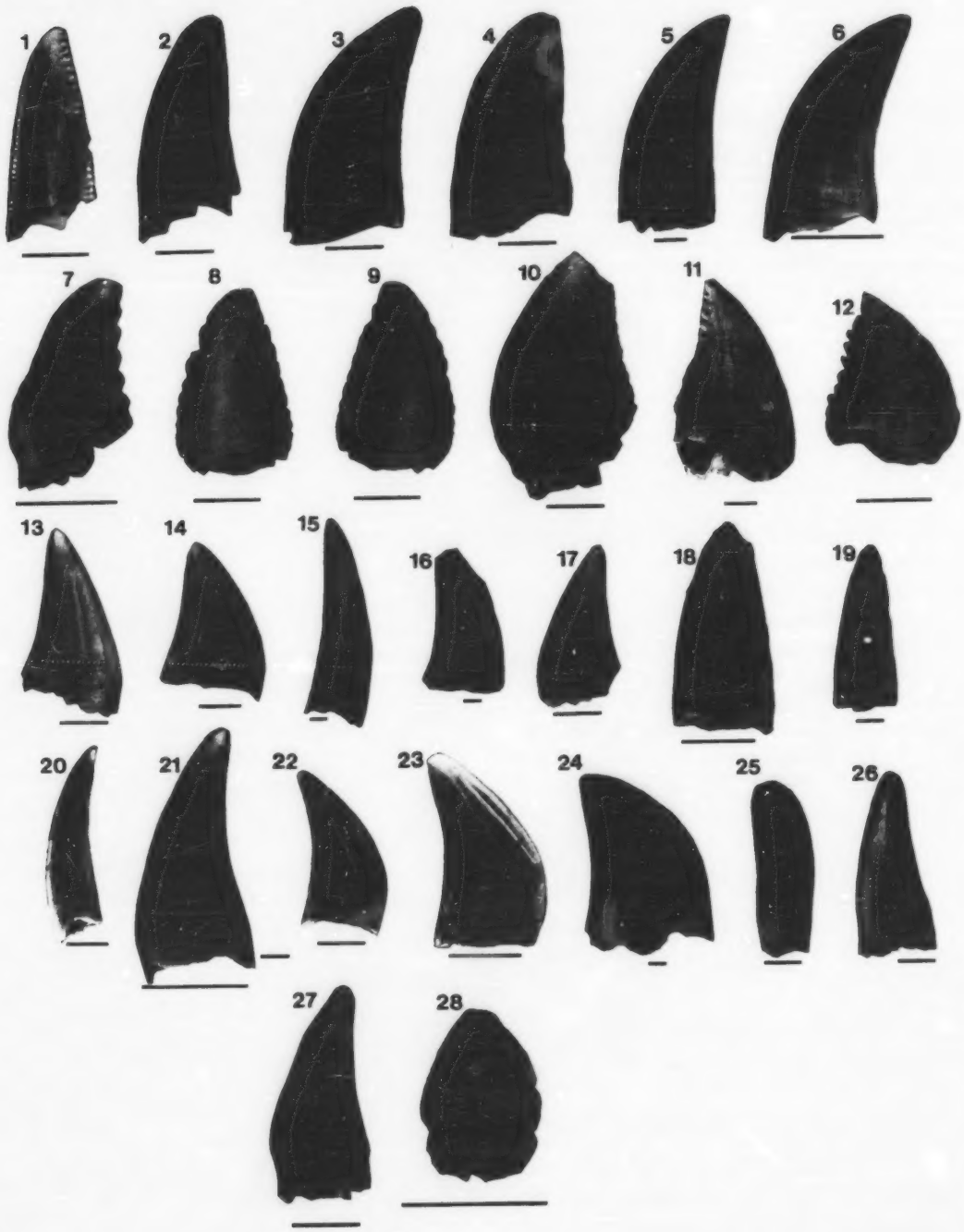
Discussion. One hundred and sixty-nine teeth of *Saurornitholestes* have been recovered through screenwashing, and 41 from surface-collecting. They exhibit similar morphological variation to that of typical specimens recovered from other upper Cretaceous strata in the area (Brinkman 1990; Currie *et al.* 1990). *Saurornitholestes* teeth have been found to be the most abundant (47.63-64.81 percent) of theropod teeth retrieved from the upper Cretaceous deposits of southern Alberta (Currie *et al.* 1990), and represent 64.81 percent of all the small theropods in this collection, versus 45 percent from the Milk River Formation (Baszio 1997a) and 47.63 percent from the Dinosaur Park Formation of DPP (Currie *et al.* 1990).

Family TROODONTIDAE Gilmore, 1924
Genus TROODON Leidy, 1856
Troodon formosus Leidy, 1856
Plate 8, figures 7-12

Troodon formosus Leidy 1856:72; Russell 1948:629; Sahni 1972:359, figs. 9L-M; Currie *et al.* 1990:113, figs. 8.3A-M; Rowe *et al.* 1992:482, fig. 5; Fiorillo and Currie 1994:77, fig. 3c.
Stenonychosaurus inequalis Sternberg 1932.
Polyodontosaurus grandis Gilmore 1932:117.
cf. *Saurornithoides* sp. Estes 1964:142, fig. 69a.
Pectinodon bakeri Carpenter 1982:129, figs. 3a-c.

Material. Isolated teeth (RTMP96.62.33-36, -59-60). The *Troodon* specimens recovered in this study include 23 complete and partial teeth from screenwashed samples and two from surface-collected samples.

Description. *Troodon* teeth are distinctive in the presence of large, sharply pointed denticles, with a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count of only two denticles per millimetre (Currie *et al.* 1990). This count is lower than that of any other known small theropod. Other diagnostic features include the robust, recurved and biconvex crowns, and the weak constriction between the crown and root. *Troodon* teeth can be distinguished easily from those of all other theropods by their characteristic denticles, the largest denticles of any known small theropod. The teeth of *Troodon* recovered in this study show little variation in their morphology and are not distinguishable from those recovered from other upper Cretaceous strata in the region.

Discussion. *Troodon* teeth are readily distinguishable from other small theropod teeth by the characteristic form of their denticles. Baszio (1997b) clarified that *Troodon* tooth specimens previously claimed to be from the Milk River Formation by Currie *et al.* (1990) were actually collected from the Judith River Group. Thus, it is suggested that the *Troodon* teeth recovered from the Oldman Formation in the course of this study perhaps represent the earliest occurrence of this animal in North America.

Family *incertae sedis*

Genus RICHARDOESTESIA Currie *et al.* 1990

Material. Thirty examples of the teeth of *Richardoestesia* were recovered in this collection, including 26 from screenwashing and four from surface-collections.

Description and Discussion. *Richardoestesia* teeth have the following diagnostic features [modified from Currie *et al.* (1990)]: they are slender and labiolingually compressed; their denticles are minute and are smaller than those of any other known theropod; and the denticle count is as high as eight per millimetre. Many of the *Richardoestesia* teeth recovered in this study exhibit weak longitudinal striations at the base of the crown.

Two types of *Richardoestesia* tooth crowns are evident: one has a recurved tip (typical of theropod crowns); the other has a straight crown with a non-recurved tip, with the crown being triangular in lateral view. The latter are often longer than the former. Baszio (1997b) identified them as representing two different species. This assignment is adopted here. Thus, the *Richardoestesia* teeth recovered in this study can be referred to two species as follows:

Richardoestesia gilmorei Currie *et al.* 1990
Plate 8, figures 13-17

Theropoda *incertae sedis* Carpenter 1982:130, fig.6.
Richardoestesia gilmorei Currie *et al.* 1990:117, figs. 8.6J-M; Rowe *et al.* 1992:482, figs. 5D-F; Baszio 1997b:38, pl. 4, fig. 49.

Material. Isolated teeth (RTMP96.62.23-32, 66).

Discussion. This species has been relatively common in upper Cretaceous strata, and is represented by those teeth of *Richardoestesia* that are diagnostic in having typical recurved crowns.

Richardoestesia sp. Baszio, 1997
Plate 8, figures 18-19

Theropoda *incertae sedis* Russell 1935:123, fig. 9; Estes 1964:143, fig. 69B.
?*Sebecosuchia* Sahni 1972:351, figs. 8Y-Z
Richardoestesia sp. Baszio 1997b:40, pl. 5, figs. 61-68.

Material. Isolated teeth referable to this species are catalogued as RTMP96.62.26 and -31.

Discussion. The teeth of *Richardoestesia* sp. are readily distinguishable from those of the other species in having straight crowns. This type of tooth has been reported from the Milk River Formation

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PLATE 8. Figs. 1-2, 4. *Dromaeosaurus albertensis*. Premaxillary teeth in lingual view: **1**, (RTMP96.62.1); **2**, (RTMP96.62.2). **4**, marginal (RTMP96.62.3) in lingual view. **Figs. 3, 5-6.** *Saurornitholestes langstoni*. Lateral view: **3**, (RTMP96.62.13); **5**, (RTMP96.62.9); **6**, (RTMP96.62.6). **Figs. 7-12.** *Troodon formosus*. Lingual view: **7**, (RTMP96.62.34); **8**, (RTMP96.62.60) (premaxillary). **9**, labial view (RTMP96.62.60). Lateral view: **10**, (RTMP96.62.36); **11**, (RTMP96.62.35); **12**, (RTMP96.62.60). **Figs. 13-19.** *Richardoestesia*. *R. gilmorei*: Lateral view: **13**, (RTMP96.62.25); **14**, (RTMP96.62.23); **15**, (RTMP96.62.30); **16**, (RTMP96.62.32); **17**, (RTMP96.62.64). *Richardoestesia* sp.: **18**, (RTMP96.62.26); **19**, (RTMP96.62.31). **Figs. 20-23.** *Paranychodon lacustris*. Lateral view: **20**, (RTMP96.62.40); **21**, (RTMP96.62.42); **22**, (RTMP96.62.44); **23**, (RTMP96.62.43). **Fig. 24.** Tyrannosauridae genus and species indet. (RTMP96.62.71) in lateral view. **Figs. 25-26.** *Aublysodon* sp. Isolated premaxillary teeth: **25**, lingual (RTMP96.62.48); **26**, lateral view (RTMP96.62.49). **Figs. 27-28.** Aves gen. indet. Lateral view: **27**, (RTMP96.62.55); **28**, (RTMP96.62.50). **Scale bars for Figs. 1-12 = 2 mm; for Figs. 13-28 = 1 mm.**

(Russell 1935), the Judith River Formation of Montana (Sahni 1972), and the Lance Formation of Wyoming (Estes 1964), but they were not named. Currie *et al.* (1990) referred these teeth to *Richardoestesia* and suspected that they represent a different species of the genus due to their distinctve morphology. More specimens retrieved by Baszio (1997b) confirm Currie *et al.*'s (1990) observation. This is also reinforced by the specimens recovered in this study.

Family *incertae sedis*
Genus PARANYCHODON Cope, 1876
Paranychodon lacustris Cope, 1876
Plate 8, figures 20-23

Paranychodon lacustris Cope 1876:256; Russell 1935:26, pl. 2, fig. 8;
Estes 1964:143; Estes *et al.* 1969:25, pl. 1d-e; Sahni 1972:360, figs. 8S-T, 9J-K; Carpenter 1982:130, fig.4.
Tripriodon caperatus Marsh 1889, pl. 3, figs. 18-22.

Material. Isolated teeth (RTMP96.62.37-47, -67-68). Eighteen *Paranychodon* teeth were recovered from screenwashed samples obtained during the course of this study.
Description and Discussion. The teeth of this taxon are recognized by having distinct longitudinal ridges on one or both sides of the tooth crown, and by its lack of denticles. All such teeth recovered in this study are small. Currie *et al.* (1990) showed that *Paranychodon* teeth are highly variable in shape, and suggested that the name *Paranychodon lacustris* be restricted to the non-serrated teeth with distinct longitudinal ridges. They referred those teeth with similar forms but bearing serrations to different small theropods (see Currie *et al.* 1990:118, figs. 8.5A-C).

The teeth of *Paranychodon* are widespread in the upper Cretaceous deposits of North America, but current understanding of the genus is poor as there is nothing known of associated material. They are, however, distinctive in terms of the diagnostic features described above. Although the *Paranychodon* teeth recovered in this study are relatively rare in absolute number, they are nonetheless distributed widely among the studied microsites.

Family TYRANNOSAURIDAE Osborn, 1905
Genus and species indet.
Plate 8, figure 24

Material. Isolated teeth (RTMP96.62.71-90).
Description and Discussion. Tyrannosaurid teeth can often be identified by their very large size, and their elongate and recurved crown bearing stout and chisel-like denticles. Juvenile or small teeth of tyrannosaurids are basically scaled-down versions of large ones and, as such, are clearly stouter than those of other small theropods that possess teeth of equivalent length. Both large and juvenile tyrannosaurid teeth were retrieved in this study, and they are very similar in morphology to those from other upper Cretaceous strata. The incompleteness of the material makes precise assignment at lower taxonomic level impossible.

Genus AUBLYSODON Leidy, 1868
Aublysodon sp.
Plate 8, figures 25-26

Material. Isolated premaxillary teeth (RTMP96.62.48-49). Only five *Aublysodon* teeth were recovered from the microsites examined in this study.
Description and Discussion. According to Molnar and Carpenter (1990), *Aublysodon* teeth are restricted to small non-serrated premaxillary teeth with a D-shaped cross-section, in contrast to those of other tyannosaurids that bear distinct serrations. The five premaxillary teeth recovered in the present study are assignable to this genus. However, Currie *et al.* (1990) questioned the validity of this genus because it was described only from tooth material. Until further study of the genus is conducted, this type of premaxillary tooth is temporaily referred to *Aublysodon* sp.

Class AVES Linnaeus, 1758
Order indet.
Plate 8, figures 27-28

Material. Isolated teeth (RTMP96.62.50-65). Twenty-seven teeth recovered in this study have been referred to Aves indet.
Description and Discussion. The teeth of Aves indet. differ from other known theropod teeth in the following features: they are small, stout but strongly laterally compressed; the crown is slightly recurved; enamel carinae are present on both anterior and posterior edges, but they lack definitive denticles; and they are prominently constricted at the base of the crown. Such teeth can be easily distinguished from the non-serrated teeth of *Paranychodon* as they lack

striations on the tooth surface. Confusion of such teeth with those of specimens of small *Leidyosuchus* is possible, but they are separable on the basis of the greater degree of lateral compression and their more pronounced recurved profile. They also differ from the teeth of known Cretaceous toothed birds (e.g., *Hesperornis* and *Ichthyornis*) in general form, suggesting that they represent one or more as yet undescribed avian taxa of the late Cretaceous.

DISCUSSION

Comparison of the lower Judith River vertebrate assemblages with those of the Dinosaur Park Formation.

The vertebrate microfossil assemblages from the upper Foremost and the Oldman formations in the Milk River region are generally comparable in taxonomic composition to those from the upper Oldman and the Dinosaur Park formations in DPP (see faunal list in Brinkman 1990). Table 1 summarizes the differences between the two assemblages.

The absence of small chondrichthyan taxa in DPP, as listed in Table 1, may well be due to minor differences in the application of retrieval techniques (i.e., an additional layer of finer screen was used in the present study during the screenwashing process). Because the specimens of the aforementioned taxa are generally small, they may well have passed through the coarser screens used by Brinkman (1990). However, the possibility cannot be ruled out that the difference reflects a real faunal difference in the two regions. Considering that: 1) the Milk River assemblage is more southerly in its location; and 2) most of these chondrichthyan taxa have been recovered from the upper Cretaceous of more southerly regions, such as Montana (Case 1978, 1987), and Texas (Welton and Farish 1993), a possible explanation for such a taxonomic difference is that there is a difference in geographic distribution (i.e., they occurred most commonly in an area south of DPP).

Phyllodontids and *Albanerpeton* have recently been identified but were not previously recognized in the upper Judith River Group of DPP (Brinkman unpublished).

The absence of *Naomichelys* in DPP is probably due to its extinction. That *Adocus* was found to be extremely rare throughout the DPP beds (Brinkman 1990), but common particularly in the Foremost Formation in the Milk River area, was suggested by Peng *et al.* (1995) to be due to a difference in geographical range (with the animal being more abundant in the more southerly parts of its distribution).

TABLE 1. Comparison of vertebrate microfossil assemblages of the Judith River Group between the Milk River area and DPP in southern Alberta, highlighting the taxa that differ between the two.

Taxa	Milk River Region Assemblage	DPP Assemblage (Brinkman 1990)
Chondrichthyans:		
Synodontaspis		
Archaeolamna		
Squatirhina		
Synechodus	Present	Absent*
Rhinobatos		
Ischyrhiza		
Chiloscyllium		
Squatina		
Albanerpeton	present	absent*
Naomichelys	present	absent
Adocus	common	extremely rare
Basilemys	rare	common

*some taxa may not have been retrieved due to different screen sizes applied during screenwashing in DPP (see the text for further details).

Conversely, another turtle, *Basilemys*, was found to have an opposite pattern of occurrence—it is relatively more common in the DPP deposits but rare in the present study beds. Thus, it may be that *Basilemys* had a more northerly distribution during the time of deposition in southern Alberta.

Although additional work is needed to clarify the taxonomic details of lizards from DPP, preliminary observations indicate that they are generally similar to those from the Milk River region (Brinkman unpublished).

Thus, the two recognized assemblages from the Judith River Group, in the Milk River region and in DPP, are generally comparable in taxonomic composition, although palaeogeographical and evolutionary influences are also evident. These patterns will be discussed in associated publications that examine stratigraphic and palaeoecological patterns evident in the Milk River region and DPP assemblages.

Summary and Conclusions.

Taxonomic description and documentation above for the non-mammalian vertebrate assemblages from the upper Cretaceous Judith River Group (including the Oldman and Foremost formations) of southern Alberta have been provided for the first time, on the basis of the evidence from vertebrate microfossil sites. Emphasis has been placed upon criteria for the identification of non-mammalian vertebrate microfossil material. Such taxonomic information is essential for any further palaeoecological study of vertebrate microfossil assemblages.

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APPENDIX 1. Names, catalogue numbers, Legal Land Descriptions, Universal Transverse Mercator (UTM) coordinates and geological information for vertebrate microfossil localities from the Judith River Group in the Milk River area of southeastern Alberta.

SPS (Suffield Pumping Station Site)
RTMP no. **L1123**
Legal Land Description: LSD 13, Sec 11, Tp. 13, Rg 9, W4.
UTM: 5546650 m N, 490100 m E Zone 12
Map name: Suffield
Map number: 72E/14
Formation: Foremost
Horizon: Upper unit
Environment of deposition: Lateral accretion

PHR-2 (Pinhorn Range #2)
RTMP no. **L1124**
Legal Land Description: LSD 4, Sec 22, Tp. 2, Rg 7, W4.
UTM: 5442025 m N, 509350 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Foremost
Horizon: Upper unit
Environment of deposition: Shoreface

PHR-1 (Pinhorn Range #2)
RTMP no. **L1125**
Legal Land Description: LSD 1, Sec 21, Tp. 2, Rg 7, W4.
UTM: 5442050 m N, 509200 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Foremost
Horizon: Upper unit
Environment of deposition: Shoreface

Ho S (Hoodoo Site)
RTMP no. **L1126**
Legal Land Description: LSD 4, Sec 7, Tp. 2, Rg 7, W4.
UTM: 5438725 m N, 504500 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Lower unit
Environment of deposition: In-channel

WS (Wendy's Site)
RTMP no. **L1127**
Legal Land Description: LSD 5, Sec 7, Tp. 2, Rg 7, W4.
UTM: 5438950 m N, 504450 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Lower unit
Environment of deposition: Splay

EZ (EZ Site)
RTMP no. **L1128**
Legal Land Description: LSD 5, Sec 7, Tp. 2, Rg 7, W4.
UTM: 5439150 m N, 504350 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Lower unit
Environment of deposition: Splay

PHS (Pinhorn South Site)
RTMP no. **L1129**
Legal Land Description: LSD 2, Sec 2, Tp. 2, Rg 7, W4.
UTM: 5436950 m N, 511725 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Lower unit
Environment of deposition: Splay

PLS (Prairie Level Site)
RTMP no. **L1130**
Legal Land Description: LSD 6, Sec 36, Tp. 1, Rg 6, W4.
UTM: 5436000 m N, 523050 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: In-channel

HAS (Hanna's Ankylosaur Site)
RTMP no. **L1131**
Legal Land Description: LSD 10, Sec 36, Tp. 1, Rg 6, W4.
UTM: 5436500 m N, 523150 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

HS (Hanna's Site)
RTMP no. **L1132**
Legal Land Description: LSD 8, Sec 34, Tp. 2, Rg 6, W4.
UTM: 5445550 m N, 520300 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

PHR 93-2 (Pinhorn Ranch #93-2)
RTMP no. **L1133**
Legal Land Description: LSD 13, Sec 23, Tp. 2, Rg 7, W4.
UTM: 5443175 m N, 511100 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Lower unit
Environment of deposition: In-channel

CS (Confluence Site)
RTMP no. **L1134**
Legal Land Description: LSD 9, Sec 34, Tp. 2, Rg 6, W4.
UTM: 5445850 m N, 520500 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

Sal S (Salamander Site)
RTMP no. **L1135**
Legal Land Description: LSD 9, Sec 35, Tp. 1, Rg 6, W4.
UTM: 5436350 m N, 521900 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

CN-2 (Cecil Nesmo's #2)
RTMP no. **L1136**
Legal Land Description: LSD 12, Sec 35, Tp. 1, Rg 6, W4.
UTM: 5436100 m N, 520800 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

CN-1 (Cecil Nesmo's #1)
RTMP no. **L1137**
Legal Land Description: LSD 16, Sec 34, Tp. 1, Rg 6, W4.
UTM: 5436600 m N, 520575 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Splay

ORS (Old Road Site)
RTMP no. **L1138**
Legal Land Description: LSD 10, Sec 35, Tp. 1, Rg 6, W4.
UTM: 5436300 m N, 521750 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Middle unit
Environment of deposition: Splay

CBC (Come-By-Chance)
RTMP no. **L1139**
Legal Land Description: LSD 2, Sec 10, Tp. 3, Rg 6, W4.
UTM: 5448650 m N, 519550 m E Zone 12

Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Channel

RDS (Rainy Day Site)
RTMP no. **L1140**
Legal Land Description: LSD 6, Sec 10, Tp. 3, Rg 6, W4.
UTM: 5449025 m N, 519400 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: In-channel

BMC (Big Muddy-Channel Site)
RTMP no. **L1141**
Legal Land Description: LSD 5, Sec 31, Tp. 1, Rg 5, W4.
UTM: 5435950 m N, 524950 m E Zone 12
Map name: Calib Coulee
Map number: 72E/2
Formation: Oldman
Horizon: Nesmo's unit
Environment of deposition: Crevasse channel

APPENDIX 2. Sedimentological and Taphonomic Description of Vertebrate Microfossil Localities

The sedimentological and taphonomic description of the microsites herein is based upon unpublished field notes by D.A. Eberth (1997). On the basis of sedimentology, these microsites are interpreted as being divisible into three sedimentary facies: in-channel deposits; crevasse splay deposits; and shallow marine deposits.

Key: O_1 = The lower unit of the Oldman Formation; O_2 = The middle unit of the Oldman Formation; O_3 = The upper unit of the Oldman Formation; F_2 = The upper unit of the Foremost Formation.

IN-CHANNEL DEPOSITS

PLS-(O_3): 4.5 m below the double bentonite at the top of the section.

Vertebrate microfossil elements are concentrated in the basal 20 cm of a 1.9 m thick, fine-grained sandstone body. The host lithosome is composed of thinning-upward sets of medium- to large-scale trough cross-beds. The fossil-bearing bed represents an intraformational lag, which has a sharp contact on a rooted siltstone, with locally cemented ironstone. Vertebrate microfossils are associated with incomplete and complete unionid valves, coaly debris, coalified wood and uncemented mudstone pebbles.

RDS-(O_3): in the same area as the CBC site, but 5.5 m higher in the section.

The RDS fossil concentrate crops out within the lower 1.5 m of a 4.5 m thick multistorey, lenticular sandstone body (representing a palaeochannel deposit). Vertebrate fossils in RDS are associated with fragmentary to complete unionid valves, contorted mudstone, fine-grained sandstone, caliche clasts, and shale rip-ups, along with large unidentified dinosaurian skeletal fragments. The RDS lithosome represents a stacked succession of lags, and passes up into medium- to large-scale cross beds.

PHR93-2-(O_1): 24.5 m above the top of the Taber Coal Zone.

PHR93-2 occurs at the base of a palaeochannel deposit. The host lithosome is a 1.25 m-thick, fining-upward sandstone body, composed of 75 cm of large-scale trough cross-beds that then pass into heterolithic inclined beds. The heterolithic beds comprise fine-grained sandstone with abundant plant debris. Vertebrate microfossil remains occur in the transition from the cross-bedding to the heterolithic inclined beds. Invertebrate shell material is conspicuously absent.

Ho S-(O_1): just adjacent to the coulee housing Wendy's site, and 8.5 m above the top of the Taber Coal Zone.

Ho S occurs in a 50 to 75 cm thick, silty sandstone body, which displays a complexly stratified, ripple laminated, and heterolithic succession. Above the host lithosome are abundant contorted heterolithic beds which contain organic and coaly debris. It probably represents a complexly interbedded lateral accretion in a palaeochannel succession. Vertebrate microfossil remains are associated with abundant, small fragments of mainly gastropod and pisidiid shells and plant debris.

SPS-(F_2): located at Suffield Pumping Station in the South Saskatchewan River area, the only one that is not from the Milk River area. This site is immediately below the Taber Coal Zone.

The vertebrate microfossil concentrates occur at the base of fine-grained, silty sandstone, associated with abundant shell fragments of gastropods and some pisidiids and small carbonaceous plant debris.

CREVASSE SPLAY DEPOSITS

BMC-(O_3): 17 m below the double bentonite at the top of the section.

BMC occurs at the base of a muddy, sandy, clayey, siltstone/sandstone. The brownish lower portion of the host lithosome indicates the presence of rich plant fragments. The lithosome fines and lightens upward into muddy, grey-to-green siltstone, which contains coalified roots. The entire host lithosome is a lens-shaped deposit that is 25 m wide and 75 cm thick at its thickest. Vertebrate microfossils are associated with abundant tree branches and gymnosperm leaves. A large, complete theropod phalanx was also found very close to the microsite. Invertebrate shell material is strikingly absent in this site.

CBC-(O_3): located in the same area as RDS, but is 5.5 m lower stratigraphically. It is suggested that CBC is at the base of the upper unit of the Oldman Formation.

CBC occurs in a 60 cm thick, sandy, clayey siltstone. The host lithosome shows very poor internal organization and becomes coarser upward, which may suggest multiple flood events. Vertebrate microfossils, concentrated at the flat base of the lithosome, are associated with shell fragments, mainly unionids with some gastropods and pisidiids and poorly sorted caliche clasts.

EZ-(O_1): 27.5 m above the top of the Taber Coal Zone.

EZ occurs at the base of a 1.5 m thick carbonaceous, clayey, silty sandstone and mudstone. The host lithosome is evidently contorted, indicative of multiple lags. Vertebrate microfossils are associated with abundant shell fragments of pisidiids, unionids and gastropods.

HS and CS-(O_2)

The two sites are associated with muddy sandstones. Their vertebrate microfossil remains are mixed with small invertebrate shell fragments, most of which are pisidiid shells, with some unionid shell fragments.

These two sites were not revisited for sedimentological and taphonomic examination after being sampled due to their location in privately owned land. Because they are located in the adjacent coulees and close to RDS, it is estimated that their stratigraphical horizon is about the same as that of RDS in the section.

PHS-(O_1): 35 m above the top of the Taber Coal Zone.

PHS occurs in a tabular, flat-bedded, carbonaceous, clayey, silty sandstone. The host lithosome is about 75 cm thick, and fines upward into siltstone, featuring contorted structure and local iron staining. Vertebrate microfossils are associated with coaly fragments, plant debris, and shell fragments of unionids, gastropods and pisidiids.

ORS-(O_2): 7 m below the base of the upper unit.

ORS occurs in a muddy, carbonaceous, clayey, silty sandstone body. The host lithosome is 1.5 m thick, and fines upward into a muddy, sandy, carbonaceous siltstone. Vertebrate microfossils are predominantly associated with pisidiid shell fragments that are very well sorted. No obvious shell fragments of unionids are present.

SN-1-(O_3): 6 m above the top of the middle unit.

Vertebrate microfossils in CN-1 occur in a 1.5 m thick, massive siltstone. The host lithosome is tabular, flat-bedded, and fines upward. Abundant shell fragments of unionids and gastropods are associated with the vertebrate microfossil remains.

CN-2-(O_3): 4.5 m above the uppermost sandstone sheet of the middle unit.

CN-2 occurs in a 1.1 m thick, muddy, clayey, silty sandstone. The host lithosome contains rich organic material, which is indicated by its evident brown colour. Vertebrate microfossil remains are predominantly associated with abundant pisidiid shell fragments.

HAS-(O_3): 14.5 m below the double bentonite layers of the section.

HAS occurs in a 1.0 m thick, brown, organic-rich, clayey, silty sandstone. The host lithosome is a vaguely to poorly developed planar stratified type, with the upper half being contorted and without obvious sedimentary structures. Vertebrate microfossil remains are associated with abundant shell fragments of pisidiids and very few unionids, and with coalified plant debris.

Sal S-(O_3): about 20 to 30 m above the middle unit.

The vertebrate fossil concentrate in SAS occurs in a 0.75 to 1.0 m thick, tabular, carbonaceous, silty sandstone. The host lithosome pinches out 30 m to the north, and passes into stacked ripple laminations with local ironstone 20 m to the south. Vertebrate microfossils are associated with abundant shell fragments of gastropods and unionids, and poorly sorted plant debris.

WS-(O_1): about 10 m above the Taber Coal Zone.

WS occurs in a 30 to 50 cm thick, clayey, silty sandstone. The host lithosome is somewhat contorted, with interbeds of clean and carbonaceous sandstone, and represents a part of a stacked splay succession. Vertebrate microfossil remains are associated with abundant shell fragments of mainly unionids and some small, disarticulated gastropods, along with abundant carbonaceous to coaly plant debris.

SHOREFACE DEPOSITS

PHR-1-(F_2): at the base of the third unit of the Foremost Formation, 25 m below the Oldman Formation.

Vertebrate microfossils in PHR-1 occur at the base of a massive (about 3.5 m thick), fine-grained sandstone body, which rests sharply on the underlying dark marine shales of the fourth parasequence of the middle (mudstone) succession. The overlying sandstone body comprises low-angled to planar sets of ripple-laminated sandstone, with a massive and pebbly base that is traceable about 10 m laterally. It is interpreted as a regressive surface of erosion that is related to a drop in relative sea-level. Vertebrate microfossil remains, including both marine and non-marine, are associated with carbonaceous plant debris, with conspicuously rare invertebrate shell fragments.

PHR-2-(F_2): lies in the stratigraphic horizon equivalent to PHR-1, but is about 400 m east of the PHR-1 site.

Vertebrate microfossil remains at the PHR-2 site are concentrated at the base of a 3.5 m thick sandstone, which comprises silty sand and finely laminated shales. The host lithosome sits with sharp contact on the fourth parasequence of the middle (mudstone) succession. The lateral extent of the site is traceable for a few metres. Abundant invertebrate shell fragments of *Corbula, Ostrea* and other unidentified marine clams are associated with the vertebrate microfossils.

APPENDIX 3. Data matrix of vertebrate assemblages from microsites of the Foremost and Oldman formations in the Milk River area of southeastern Alberta, as reported in this study. The numbers indicate the number of identifiable elements.

Taxa	PHR-1	PHR-2	SPS	Ho S	WS	EZ	PHR93-2	CS	PHS	Sal S	HAS	HS	CN-1	CN-2	ORS	CBC	RDS	BMC	PLS
Hybodus	10	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synodontaspis	23	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Archaeolamna	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chiloscyllium	0	6	5	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0
Rhinobatos	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ischyrhiza	8	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myledaphus	1952	2164	235	15	9	8	24	2	19	1	2	6	2	0	2	1	102	0	14
Squatina	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synechodus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acipenseridae	90	25	14	6	0	0	4	0	6	0	0	0	0	0	0	0	0	0	0
Holostean A	94	22	229	54	138	1	31	49	1	32	32	36	57	5	55	19	73	0	9
Holostean B	355	166	45	0	25	4	5	0	0	0	0	0	0	0	0	0	0	0	0
Belonostomus	185	160	0	0	11	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Atractosteus	2463	834	204	1001	404	147	126	169	339	10	126	107	30	14	10	123	0	6	30
Amiidae	9	17	5	10	11	18	14	0	0	4	17	2	0	0	0	7	1	0	3
Paralbula	1125	1987	136	6	5	4	14	1	43	0	1	3	1	0	1	0	0	0	0
Phyllodontinae indet.	31	29	3	6	11	4	5	3	2	0	7	6	15	0	1	12	9	0	2
Coriops	3	5	16	26	35	26	16	18	19	12	24	7	22	2	7	7	3	2	0
Estesesox	4	7	29	7	15	4	6	18	1	7	10	13	22	2	10	10	15	0	5
Teleost D	7	25	6	41	28	16	27	0	16	8	17	15	26	6	6	25	13	0	0
Teleost indet.	89	265	46	100	225	150	101	6	148	48	141	197	230	36	144	73	34	10	1
Scapherpeton	12	30	202	166	216	36	138	219	44	64	222	188	206	48	119	129	68	42	20
Opisthotriton	29	66	199	78	38	30	68	145	14	33	238	187	210	16	158	29	11	13	19
Albanerpeton	0	7	8	6	63	16	17	14	15	8	14	18	9	20	7	0	1	4	0
Anura indet.	33	31	24	47	75	43	70	66	29	40	92	90	102	33	33	147	44	35	15
Baenidae indet.	93	2	18	2	11	1	4	16	13	4	5	6	5	8	10	6	14	2	2
Chelydridae indet.	21	1	4	14	5	2	0	15	0	3	0	1	9	15	23	6	10	12	2
Adocus	129	3	0	13	8	4	0	7	15	0	0	0	0	0	0	0	0	0	0
Basilemys	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trionychidae indet.	106	7	1	2	14	6	2	18	24	1	3	14	6	4	12	17	14	6	3
Naomichelys	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Socognathus	0	0	0	1	0	0	0	5	2	0	0	0	0	0	0	0	0	0	4
Leptochamops	2	2	0	0	2	4	4	0	0	1	3	4	2	2	4	7	1	4	0
Gerontoseps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Odaxosaurus cf. *O. priscus*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0
cf. *Odaxosaurus piger*	3	0	1	0	33	41	5	0	11	0	5	4	0	0	0	0	0	1	0
Colpodontosaurus cf. *C. cracens*	0	0	3	1	3	0	0	0	0	0	0	0	2	0	2	0	0	0	0
cf. *Paraderma bogerti*	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
Helodermatidae indet.	7	6	3	3	0	14	0	7	9	3	0	16	3	0	0	2	3	2	1
Xenosauridae indet.	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
cf. *Paleosaniwa canadensis*	0	3	0	2	7	0	2	1	0	1	1	2	3	5	2	2	0	0	0
Varanoidea indet.	0	0	0	0	0	0	0	3	2	0	0	1	1	1	1	0	0	1	2
Champsosaurus sp.	97	213	50	17	214	6	18	37	27	7	6	14	1	2	4	2	9	0	10
Leidyosuchus sp.	112	190	33	28	73	11	19	90	40	19	20	82	11	5	3	19	100	1	27
Alligatorinae indet.	10	15	5	3	9	2	1	3	11	1	1	0	0	0	1	2	18	0	3
Hadrosauridae indet.	178	263	162	83	61	101	65	219	93	132	268	108	136	50	99	87	295	54	128
Ceratopsidae indet.	52	12	2	3	8	11	10	10	2	15	10	12	13	2	5	17	19	5	6
Nodosauridae indet.	4	2	2	0	0	1	0	3	0	1	2	1	0	0	2	0	1	1	8
Ankylosauridae indet.	4	6	0	2	0	0	0	2	2	0	3	1	0	1	3	1	5	0	2
Pachycephalosauridae indet.	2	0	2	0	1	1	0	2	0	0	0	1	0	0	0	0	2	3	1
Dromaeosaurus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0
Saurornitholestes	7	18	2	6	7	1	11	6	7	5	8	4	10	1	1	7	41	4	25
Troodon	0	0	0	0	0	0	0	1	0	0	0	0	2	1	0	4	12	0	2
Richardoestesia	3	3	0	2	0	0	0	2	0	0	2	2	0	2	2	3	7	0	1
Paranychodon	0	1	2	0	2	0	1	1	1	1	2	3	0	1	1	0	0	1	2
Tyrannosauridae indet.	5	9	1	2	3	1	0	4	2	2	1	1	3	0	1	3	3	4	3
Aublysodon sp.	2	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	0	0
Aves indet.	3	0	3	0	3	1	1	2	0	0	2	4	2	1	3	0	2	0	1
Total	7364	6740	1700	1754	1776	716	810	1157	958	463	1288	1156	1142	284	739	767	936	214	352

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